



WARNING

THIS MANUAL CONTAINS SERVICING INSTRUCTIONS THAT ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATORS MANUAL UNLESS QUALIFIED TO DO SO.

**413
PORTABLE
NEONATAL MONITOR
WITH OPTIONS
SERVICE**

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____



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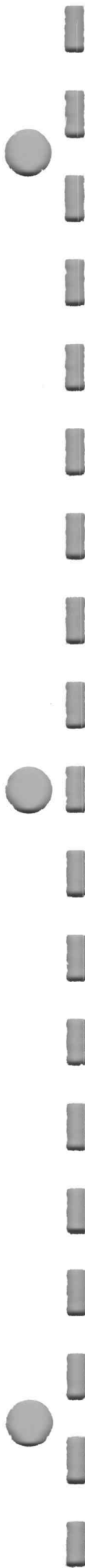
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SAFETY INFORMATION

For Qualified Service Personnel Only.

The 413 Neonatal Monitor has fully isolated ECG circuitry and is suitable for use with electrically susceptible patients when operated from either the specific ac power source or the internal battery pack. Respiration/ECG leakage current does not exceed 10 μ A rms at 120 V, 60 Hz.

Electric appliances applied to a patient create hazards for both the patient and the operator unless the equipment is suitable for the application and the operator is skilled in its use. Several appliances used simultaneously compound the hazard situation.

This manual contains safety information which you as the user must follow to endure safe operation of the monitor. WARNING information is intended to protect the patient and the operator, and CAUTION information is intended to protect the instrument. The following general safety precautions must be applied during all phases of operation and maintenance.

WARNING

DO NOT OPERATE MONITOR IN AN EXPLOSIVE ATMOSPHERE

Do not operate the monitor in the presence of flammable gasses or anesthetics. Explosion can result from operation in such an environment. Safety document NFPA 56A, Standard for the Use of Inhalation Anesthetics, states that portable electronic equipment (such as this Monitor) must not be operated at less than five feet above the floor in the presence of flammable anesthetics.

USE AC OUTLET WITH PROTECTIVE-GROUND CONTACT

The monitor is compatible with isolated power systems as used in operating rooms. In non isolated power systems, this monitor is intended to be operated from a single-phase, earth-referenced power source having one current-carrying conductor (the neutral or grounded conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-to-phase on a three-wire system) is not recommended, since only the line (or ungrounded) conductor has over-current (fuse) protection within the monitor.

The monitor has a three-wire (18 gauge, SJT-grade) power cord and is normally supplied with a three-terminal polarized plug (Hospital Grade) for connection to the power source and protective ground. The protective ground (earth) terminal of the plug is directly connected to the frame of the monitor. For electric-shock protection, insert this plug only in a mating "Hospital Grade" power outlet with a protective-ground contact. Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard.

Inspect the power cord periodically for fraying or other damage. Do not operate the monitor from an ac power source if the power cord or plug is damaged.

The power cord on the monitor is color-coded to conform to IEC (International Electromagnetic Commission) requirements as follows:

CONDUCTOR	COLOR
Line (ungrounded)	Brown
Neutral (grounded)	Light blue
Protective ground	Green or green w/yellow stripe

USE ONLY SAFE METHODS OF INTERCONNECTION

To ensure protection against electrical shock from the monitor cabinet, whenever auxillary-operated equipment is electrically connected to the monitor, the monitor must be properly grounded. When the monitor is connected to other line-operated equipment, battery operation should be avoided. If it cannot be avoided, the monitor must be grounded using the terminal provided on the rear panel. It is extremely important that equipment interconnections are made in accordance with NFPA 76B-T, Tentative Standard for the Use of Electricity in Patient Care Areas of Health Care Facilities, section 3038, "Signal Transmission Between Appliances." Also see NFPA No. 70, National Electrical Code, Article 517, "Health Care Facilities."

NOTE

Within certain governmental jurisdictions, all interconnected accessory equipment must be labeled by an approved testing laboratory. After interconnection with accessory equipment, leakage current and grounding requirements must be maintained.

WARNING

Avoid electrocautery burns at monitoring sites by ensuring proper connection of the electrocautery return circuit. If improperly connected, many older electrocauterizers allow other return paths, even through fully isolated patient monitors.

DO NOT REMOVE INSTRUMENT COVERS

High voltage is present inside the monitor. To avoid electric-shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

USE ONLY SPECIFIED ACCESSORIES

*To ensure patient safety, use **only** accessories specified by Tektronix, Inc. The following is a partial listing of accessories that are specified by Tektronix, Inc. for use with the 413 Neonatal Monitor.*

Patient Cable:	Torso/Respiration. Tektronix Part 012-0739-00.
Electrodes:	Disposable snapfit, infant monitoring. Tektronix Part 119-0898-00. Needle, Grass platinum E2/B, ECG type. Available from Grass Instrument Company, 101 Old Colony Avenue, Quincy, Massachusetts 02169.
Electrode Wires:	18-inch detachable, with snap fittings. Tektronix Part 012-0502-00.
Pressure Transducers:	Gould-Stathem P-23 Id, Tektronix Part 015-0233-00. Bentley Trantec 800, Tektronix Part 015-0234-00. Bell & Howell 4327-I, Tektronix Part 015-0235-00.
Peripheral Pulse Sensors:	Radial pulse sensor. Tektronix Part 015-0237-01.
Temperature Sensors:	Dual-thermistor temperature probe. 700 series available from the Yellow Springs Instrument Co., Box 279, Yellow Springs, Ohio 45837.

DO NOT MOUNT MONITOR DIRECTLY ABOVE PATIENT

Place monitor in a location where it cannot harm the patient should it fall from its shelf or other mount.

CAUTION

USE ONLY RECOMMENDED STERILIZATION METHODS

Do not autoclave accessories (or monitor) unless the manufacturer's instructions clearly approve this procedure. Many accessories can be severely damaged by autoclaving. Also inherent isolation may be destroyed.

Pressure Transducers

All transducers recommended by Tektronix, Inc. can be gas sterilized. However, adequate time must be allowed after sterilization for the ethylene oxide (which is absorbed by the plastics in the transducer) to be dissipated. Refer to the manufacturer's instructions.

Pre-sterilized, disposable domes are available for some types of transducers; contact the transducer manufacturer or his representative. These domes have an integral isolation diaphragm which prevents fluid contact with the transducer and thereby eliminates the need for transducer sterilization.

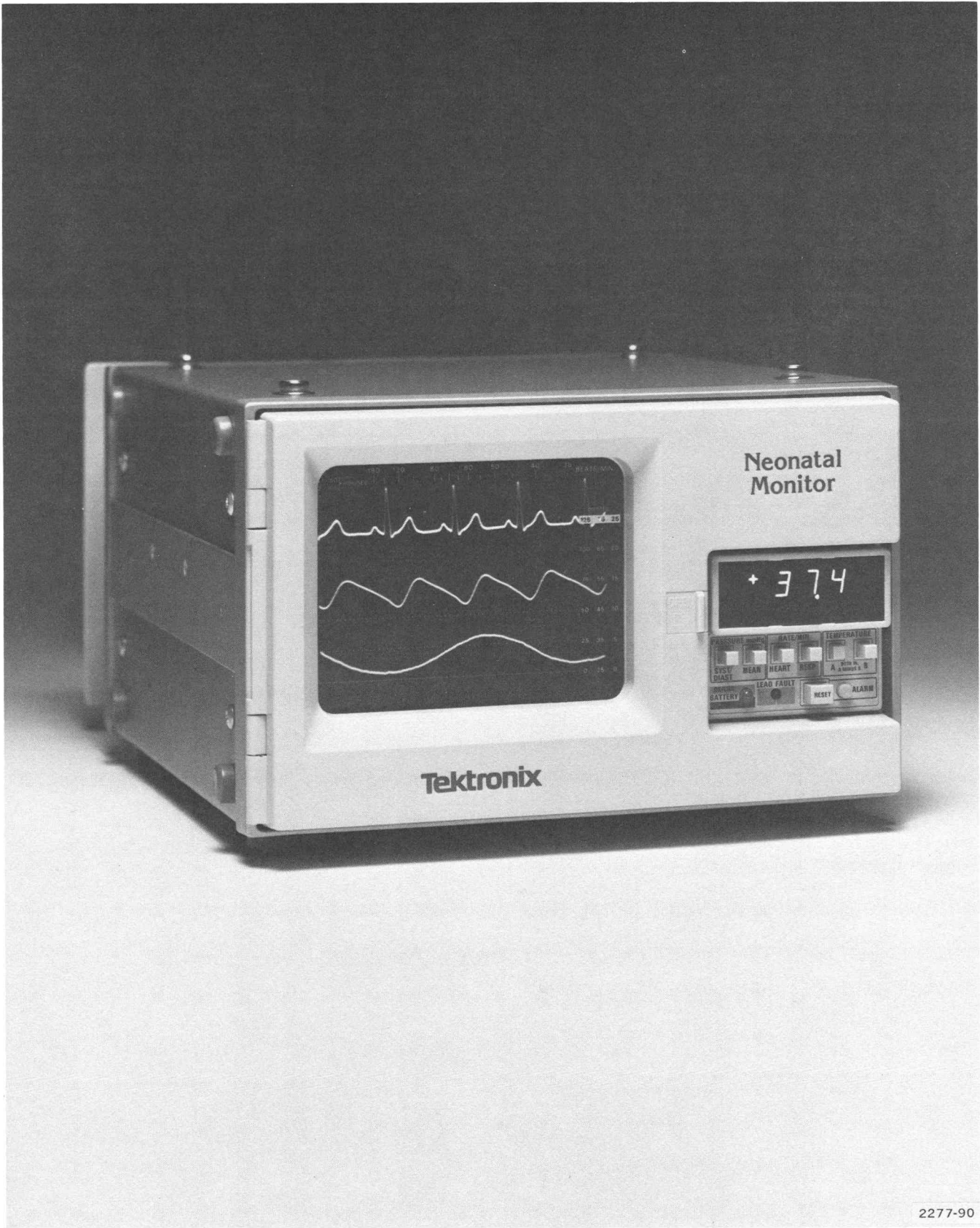
Pulse Sensors. *Usually pulse sensors do not require sterilization. Sensors can be cleaned by wiping with an alcohol-dampened pad.*

Temperature Sensors. *Temperature sensors can be gas sterilized. However, adequate time must be allowed after sterilization for the ethylene oxide (which is absorbed by the plastics in the sensor) to be dissipated.*

SAFETY DOCUMENTS

Additional safety information can be found in the following organizations and documents:

1. Canadian Standards Association 178 Rexdale Blvd., Rexdale, Ontario, Canada M9W 1R3 CSA Standard C22.2, No. 125-1973 Electro-Medical Equipment.
2. Underwriters Laboratories, Inc. 1285 Walt Whitman Road, Melville, L.I., New York 11746, UL544, Standard for Safety Medical and Dental Equipment.
3. National Fire Protection Association (NFPA), 470 Atlantic Avenue, Boston, Massachusetts 02210.
 - a. NFPA NO. 56A, 1973, Standard for the Use of Inhalation Anesthetics.
 - b. NFPA NO. 70, 1978, National Electrical Code.



413 Neonatal Monitor

GENERAL INFORMATION

DESCRIPTION

The 413 is a portable neonatal monitor that displays ECG, blood pressure or peripheral pulse, and respiration. The digital readout displays systolic/diastolic blood pressure, mean blood pressure, heart rate, respiration rate or temperature. The monitor can be operated from an ac power line source, or the internal rechargeable F-cell battery pack. On-location evaluation of common cable and electrode problems is provided by the ECG LEAD CHECK signal source and the LEAD FAULT indicator.

A three-trace display is provided for simultaneous viewing of the ECG, blood pressure or pulse, and

respiration waveforms. The traces are automatically positioned for the mode of operation selected. Trace intensity and focus are internally preset.

Adjustable alarm limits are provided for heart rate and respiration rate. Independent controls are provided for continuous-tone-alarm loudness and for beat-tone loudness. Separate QRS and INSPIRATION detectors provide information for the rate alarms, rate digital display, and sweep triggering. A pulse alarm indicates pulse or pressure failure.

Other features include a color-changing LED (Light-Emitting-Diode) to indicate battery condition, and a "Hospital Grade" power plug.

SPECIFICATION

The following electrical characteristics apply over an ambient temperature range of 0° to 50°C when the monitor has been calibrated in a +25°C, ±5°C environment.

TABLE 1-1
Electrical

Characteristic	Performance Requirement	Supplement Information
ECG		
INPUT		
Lead Selection	ECG Off, Lead I, Lead II, Lead III.	
Isolation (combined total ECG and Resp)	Instrument only—does not include effects of patient cable.	
Capacitance		Less than 50 pF.
Resistance		Greater than 10 ¹⁰ Ohms.
Leakage Current	Less than 10 μ A rms at 120 Vac 60 Hz.	
Breakdown	Greater than 2.5 kV rms at 60 Hz between isolated and grounded circuits.	Greater than 5 kV dc between isolated and grounded circuits.
Self Protection (ECG and Resp)		
Defibrillator and Cauterizer	Monitor may remain connected to patient during defibrillation and electrocautery when used with a Tektronix patient cable.	No damage to monitor when patient cable contains 1000 ohm resistor in series with each electrode. Resistors in cable may open in extreme cases.

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
ECG(cont)		
TRANSFER CHARACTERISTICS		
Bandwidth	0.5 Hz ($\pm 25\%$) to 50 Hz ($\pm 25\%$) at -3 db points.	
CMRR	No less than 500,000:1 at 60 Hz with 15 k ohm maximum electrode resistance and 5 K Ω imbalance.	No less than 350,000:1 at 10 k ohm imbalance.
Input Signal dc Offset Range	No degradation of signals having ± 250 mV or less dc offset.	
Overdrive Recovery	2 seconds or less.	1 second typical.
Noise	Less than 10 μ V rms referred to input.	As measured with true rms responding meter at ECG rear panel output. Bandwidth limited to 100 Hz.
Lead Fault Indicator	Responds to information from either ECG or Respiration channel.	Activation from ECG channel indicates loss of effective ECG amplifier input connection to patient.
Trace Baseline Overshoot Following Pacer Signal		Less than 250 μ V (referred to input).
Input to Display Sensitivity	20 mm/mV $\pm 10\%$ when SIZE control is set at index on front panel. Variable from at least $\div 2$ to X 2 from index.	Typical variable range: $\div 3$ to X 3.
Input to Output Gain	X1000 $\pm 5\%$.	± 5 V minimum linear output range when status of SIZE control and automatic trace positioning are such that signal is displayed completely on screen. ± 12 V out maximum during overdrive conditions. Less than 100 ohm R_o single-ended output shortproof to ground. Load resistance 100 k ohms minimum.
QRS DETECTOR		
Initializing Time	Less than 10 seconds.	
R Edge Timer		Initial value, 5 ± 1 ms. Self-adjusting between 5 and 8 ms.
Inhibit Timer and QRS Output Pulse Width		150 ms ± 25 ms.

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
ECG (cont)		
LEAD CHECK SIGNAL		
Amplitude		
Lead I	1.0 mV $\pm 5\%$.	
Lead II	1.5 mV $\pm 5\%$.	
Lead III	0.5 mV $\pm 5\%$.	
Rate	117 bpm ± 3 bpm.	
RESPIRATION		
INPUT		
Leads Monitored	LA to RA, independent of ECG lead selector.	
Technique	Constant current impedance pneumography.	
Excitation Frequency		50 kHz $\pm 20\%$
Excitation Amplitude		70 μ A rms $\pm 50\%$.
Patient Source Impedance Range	1.5 k ohm maximum @ 50 kHz.	
Isolation (Combined Total ECG and Resp)	Instrument only — does not include effects of patient cable.	
Capacitance		Less than 50 pF.
Resistance		Greater than 10^{10} ohms.
Leakage Current	Less than 10 μ A rms at 120 Vac 60 Hz.	
Breakdown	Greater than 2.5 kV rms at 60 Hz between isolated and grounded circuits.	Greater than 5 kV DC between isolated and grounded circuits.
Self Protection (ECG and Resp)		
Defibrillator and Cauterizer	Monitor may remain connected to patient during defibrillation and electrocautery when used with a Tektronix patient cable.	No damage to monitor when patient cable contains 1000 ohm resistor in series with each electrode. Resistors in cable may open in extreme cases.

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
RESPIRATION (cont)		
INPUT (cont.)		
Bandwidth	0.1 Hz ($\pm 25\%$) to 4 Hz ($\pm 25\%$) at -3 db points.	
Noise	Less than 0.1 ohm rms at 750 ohm input source impedance, referred to input.	As measured with true rms responding meter at Resp rear panel output. Bandwidth limited to 10 Hz.
Overdrive Recovery	5 seconds or less.	2 seconds typical.
Lead Fault Indicator	Responds to information from either ECG or Respiration channel.	Activation from respiration channel indicates unsuitable conditions in LA to RA lead/electrode system for respiration monitoring.
Input to Display Sensitivity	20 mm/ Ω $\pm 25\%$ when SIZE control is set at index on front panel. Variable from at least $\div 4$ to X4.	Typical variable range: $\div 5$ to X5.
Display to output Sensitivity	0.5 V/cm of display, $\pm 10\%$.	± 5 V minimum linear output range when signal is completely on screen. ± 12 V maximum during overdrive conditions. Less than 100 ohms R_o single-ended output short-proof to ground. Load resistance 100 k ohm minimum.
INSPIRATION DETECTOR		
Initializing Time	Less than 30 seconds.	
Inspiration Phase Timing		100 ms ± 15 ms.
Inhibit Time and Inspiration Output Pulse Width		150 ms ± 25 ms following end of inspiration phase.
PRESSURE/PULSE		
PRESSURE		
Ranges		All three ranges can provide one centimeter of display below bottom and one cm of display above top of marked scale.
0–125	–25 to +150 mmHg.	
25–75	+15 to +85 mmHg.	
0–25	–5 to +30 mmHg.	

TABLE 1-1 (CONT.)

Electrical

Characteristics	Performance Requirements	Supplemental Information
PRESSURE/PULSE (cont.)		
PRESSURE (cont.)		
Display Accuracy	Within 5% of full scale on each graticule range, or 3 mmHg., whichever is greater.	
Pressure Output (rear panel)	0.5 V/cm of display, within 5%.	−0.5 V to +3.0 V full scale on each range. ± 7 V out maximum during overdrive conditions. Less than 100 ohms R_O single-ended output short-proof to ground. 100 k ohm or more load resistance.
Excitation Voltage		± 8 V pulsed.
Excitation Time		Approximately 1 ms each cycle.
Chop Rate		62.5 Hz $\pm 2\%$.
Bandwidth		Dc to 20 Hz $\pm 25\%$.
100 mm Check	100 mmHg $\pm 2\%$.	
Zero Drift	Less than 3 mmHg per hour.	After 5 min warmup.
PULSE		
SIZE Range	15:1 or more.	20:1 typical.
Pulse Output (Rear Panel)	0.5 V/cm of display, within 10%.	−0.5 V to +3.0 V full scale on each range. ± 7 V out maximum during overdrive conditions. Less than 100 ohms R_O single-ended output short-proof to ground. 100 k ohm or more load resistance.
Overdrive Recovery	5 seconds or less.	
ALARMS		
LIMITS		
High	90-240 beats/min. 45-120 breaths/min. Setting can be verified on digital display by pushing control knob.	Within 2 beats/min or 2 breaths/min relative to heart or respiration rate digital readout.
Low	From less than 30 to 150 beats/min. From less than 5 to 75 breaths/min. Setting can be verified on digital display by pushing control knob.	Within 2 beats/min or 2 breaths/min relative to heart or respiration rate digital readout.

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
ALARMS (cont.)		
VIOLATIONS		
Rate	Alarm is triggered when the average rate remains outside of selected limits for 3-15 seconds.	
Pulse	Alarm is triggered when pulse display amplitude remains below 0.3 cm for 3-15 seconds.	Alarm will not be triggered if pulse display amplitude exceeds 0.5 cm.
Pressure	Alarm is triggered when average pulsatile pressure (systolic minus diastolic) remains below 5 mmHg for 3-15 seconds.	Alarm will not be triggered when average pulsatile pressure exceeds 10 mmHg.
Apnea	Alarm is triggered when no breaths are detected for 15 (± 5) seconds or 30 (± 10) seconds as selected by front panel switch.	
OUTPUT		
Front Panel	Lights alarm lamp (yellow); sounds audio continuously.	
Rear Panel	Signal provided between ring and barrel of rear panel phone jack.	12 mA current source, voltage limited at about +5.5 V; +7 V maximum.
RESET		
Front Panel	Clears audio for 45 seconds (± 15 seconds); lamp remains on until violation clears. Audio clears when violation clears, independent of reset action.	
Rear Panel (remote)	Switch closure between tip and barrel of phone jack on rear panel will reset alarm if violation has cleared.	Requires no more than 100 μ A current sink to reset alarm.
DIGITAL DISPLAY		
TYPE	Gas-discharge, .33 inch high.	
UPDATE TIME	Between 0.75 and 1.25 sec.	1 second typical. During overrange or push-to-read functions, update rate is 5 Hz $\pm 50\%$.
OVERRANGE FLASH RATE		5 Hz $\pm 50\%$.
POLARITY	+ or — signs automatically displayed in pressure and temperature modes.	

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
DIGITAL DISPLAY (cont)		
ZERO SUPPRESSION	All leading zeros blanked except the one just preceding the decimal.	
HEART RATE		
Source	ECG, whenever channel is on; Pressure or Pulse when ECG is off.	
Overrange Indication		Any R-R interval corresponding to greater than 300 bpm $\pm 10\%$ causes readout to flash.
Accuracy (30 to 250 bpm)	2% reading or 3 bpm, whichever is greater.	
Response Time	Settles to final value $\pm 5\%$ of step within 12 seconds after step change in rate.	10 seconds typical.
Ripple (at 30 bpm)	2 bpm or less.	1 bpm typical.
RESPIRATION RATE		
Overrange Indication		Any breath-to-breath interval corresponding to a value greater than 150 breaths/min $\pm 10\%$ causes readout to flash.
Accuracy (5 to 120 breaths/min)	Settles to final value $\pm 5\%$ of step within 35 seconds after step change in rate.	30 seconds typical.
Ripple (at 5 breaths/min)	2 breaths/min or less.	1 breath/min typical.
PRESSURE		
Ranges		Pressure readout range is equivalent to screen display for the range selected. This applies even when waveform display is turned off.
0–125	–25 to +175 mmHg.	
25–75	+15 to +95 mmHg.	
0–25	–5 to +35 mmHg.	
Source	Pressure channel when any pressure range is selected.	Pulse selection causes pressure readout blanking. Also readout is blanked when pressure transducer is not connected.
Accuracy	2% of reading or 3mmHg, whichever is greater, excluding transducer error and zero imbalance.	

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
DIGITAL DISPLAY (cont)		
Systolic/Diastolic Display Cycle	3 seconds $\pm 25\%$.	ONE COMPLETE CYCLE Systolic 0.9 second Blank 0.1 second Diastolic 0.9 second Blank 1.1 seconds (Typical Values)
Mean		Systolic/Diastolic peaks must be within selected range (on screen).
Zero	Set with front panel control. Pressing control allows zero reading to be viewed on digital display.	
Systolic/Diastolic/Mean Response Time	Settles to final value $\pm 5\%$ of step within 12 seconds after step change in pressure.	10 seconds typical.
Ripple (at 30 mmHg)	2 mmHg or less.	1 mmHg typical.
Overrange Indication		Digital display flashes when pressure trace leaves screen area (even momentarily).
TEMPERATURE		
Accuracy (with Yellow Springs Instrument 700 Series Probes) T_A or T_B	$\pm 0.3^\circ\text{C}$ ($\pm 0.5^\circ\text{F}$) over a range of $+5^\circ\text{C}$ to $+45^\circ\text{C}$ (41°F to 113°F) for instrument ambient temperature from $+15^\circ\text{C}$ to $+35^\circ\text{C}$. $\pm 0.5^\circ\text{C}$ ($\pm 0.9^\circ\text{F}$) over same range for full instrument ambient temperature of 0°C to $+50^\circ\text{C}$.	
$T_A - T_B$	$\pm 0.6^\circ\text{C}$ ($+1.0^\circ\text{F}$) over a range of $+5^\circ\text{C}$ to $+45^\circ\text{C}$ (41°F to $+113^\circ\text{F}$) for instrument ambient temperature range of $+15^\circ\text{C}$ to $+35^\circ\text{C}$.	
Response Time	Settles to within 0.1°C (0.2°F) of final reading within two seconds after step function change in probe output.	One second typical.
Overrange Indication		Digital display flashes when temperature is less than a value between -10°C and -5°C or greater than a value between $+45^\circ\text{C}$ and $+50^\circ\text{C}$ ($+14^\circ\text{F}$ and $+23^\circ\text{F}$, $+113^\circ\text{F}$ and 122°F).

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
WAVEFORM DISPLAY AND AUDIO		
TRIGGERING		
Auto Baseline Delay	3 to 5 seconds after last trigger.	4 seconds typical.
SWEEP		
Speeds	12.5, 25, 50, 100 mm/second.	
Accuracy	Within 5% of reading at 50 and 100 mm/sec, rated against heart rate scale, for ambient temperature range +15 to +35°C.	Within 5% of reading at 12.5 and 25 mm/sec, rated against external metric scale, for ambient temperature range +15 to +35°C.
Triggering	Sweep is triggered only on 50 and 100 mm/sec speeds.	Sweep is free-running on 12.5 and 25 mm/sec speeds.
AUDIO		
Alarm	Continuous tone.	
Beat Tone	Burst of same tone as alarm.	

POWER

POWER LINE		
Power Cord and Plug	Plug is Hospital Grade (NEMA 5-15 P) Cord is 18 AWG SJT and meets IEC Color Code requirements.	Line, brown; neutral, light blue; protective ground, green w/yellow stripe.
Voltage Range		
115 Vac	103.5 to 136 Vac.	
230 Vac	207 to 250 Vac.	
Frequency	48 to 440 Hz.	
Power Consumption		
Current	0.45 A or less at 115 Vac, 60 Hz.	
VA	45 VA or less at 115 Vac, 60 Hz.	
Isolation (primary to secondary and primary to core)		
Breakdown	1500 V rms.	
Chassis Leakage Current	Less than 50 μ A at 120 Vac, 60 Hz (protective ground wire current).	

TABLE 1-1 (CONT.)
Electrical

Characteristics	Performance Requirements	Supplemental Information
POWER (cont)		
INTERNAL BATTERY (F cells)		
Voltage		5.0 nominal.
Operating Time	1.5 hours minimum with new battery, operating in three-trace mode with pulse sensor attached and all traces on screen. Battery must have been charged for 14-16 hours in ambient temperature environment between 0°C and 25°C, with monitor turned off.	3 hours typical. When battery has been charged with monitor operating, run time is reduced by about 1/3.
Battery Status Indicator	Red/green LED changes color from green to orange to red to indicate battery status.	
Charging Current		560 mA \pm 50 mA.
Charge Shutdown		Drops charging current to trickle as internal temperature increases.
Low-Battery Shutdown		4.60 V \pm 50 mV.

TABLE 1-2
Environmental

Characteristics	Performance Requirements	Supplemental Information
<p>TEMPERATURE</p> <p>Operating</p>	<p>0°C to +50°C.</p>	<p>NOTE</p> <p><i>Battery charging should be done in an environmental temperature between 0°C and 25°C. The greater the temperature above +25°C the less charge the battery will accept, regardless of attempted compensation through extended charge time. Continuous battery charging is prevented in ambient temperature above about 25°C when monitor is operating and above about 35°C when monitor is off.</i></p> <p>CAUTION</p> <p><i>Extended operation below 0°C may reduce the life of the gas-discharge digital display devices.</i></p>
<p>Storage</p>	<p>−40°C to −60°C.</p>	
<p>ALTITUDE</p>	<p>To 15,000 feet.</p>	

TABLE 1-3
Physical

Characteristics	Description
WEIGHT	
Without Battery Pack	6 kg (13 lbs).
With F-Cell Battery Pack	7 kg (16 lbs).
HEIGHT	
Including Feet	14.1 cm (5.6 inches).
WIDTH	
Including Handle	23.1 cm (9.0 inches).
Including Handle and Adapter	23.9 cm (9.5 inches).
DEPTH	
Including Cord Wraps and Front Cover	25.6 cm (10.0 inches).
	31.8 cm (12.5 inches).

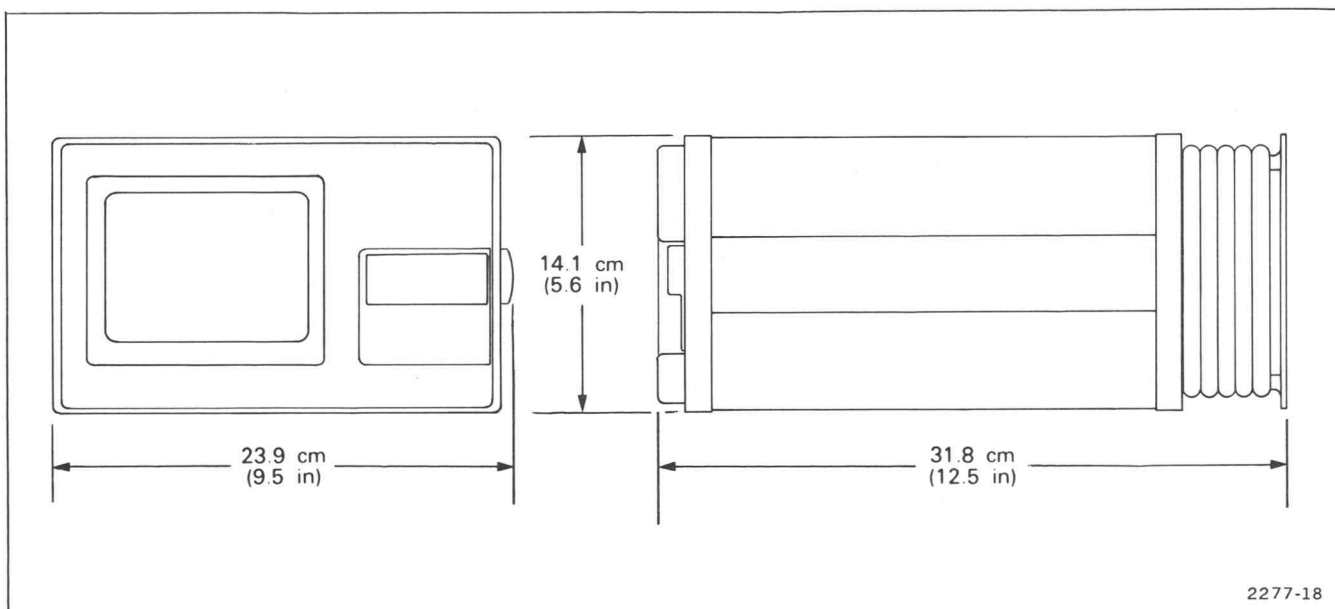


Figure 1-1. Dimensional outline drawing.

STANDARD ACCESSORIES

The following accessories are included with the 413 Neonatal Monitor:

- 1 ea.....Operators Manual
- 1 ea.....Service Manual
- 1 ea.....Accessory Pouch
- 1 ea.....Torso/Respiration Patient Cable
- 2 sets.....Electrode Wires,set of 3
- 9 ea.....Infant ECG Electrode
- 1 ea.....Mounting Adapter
- 1 ea.....Crt Scale Retainer

For more detailed information, refer to the tabbed Accessories page in the back of this manual.

INSTALLATION

MOUNTING

The following accessories are available for mounting the 413:

MOUNTING KIT

Includes Mounting Stand to mount monitor at five-foot level. Attaches to vertical pipes or surfaces of anesthesia machines or similar devices.

Tektronix Part 016-0110-00.

MOUNTING BRACKET

Attaches to top of Mounting Stand. Mates with Mounting Adapter below.

Tektronix Part 407-1797-00.

MOUNTING ADAPTER

Attaches to monitor. Mates with Mounting Bracket above. (Included with monitor as a standard accessory.)

Tektronix Part 014-0054-00.

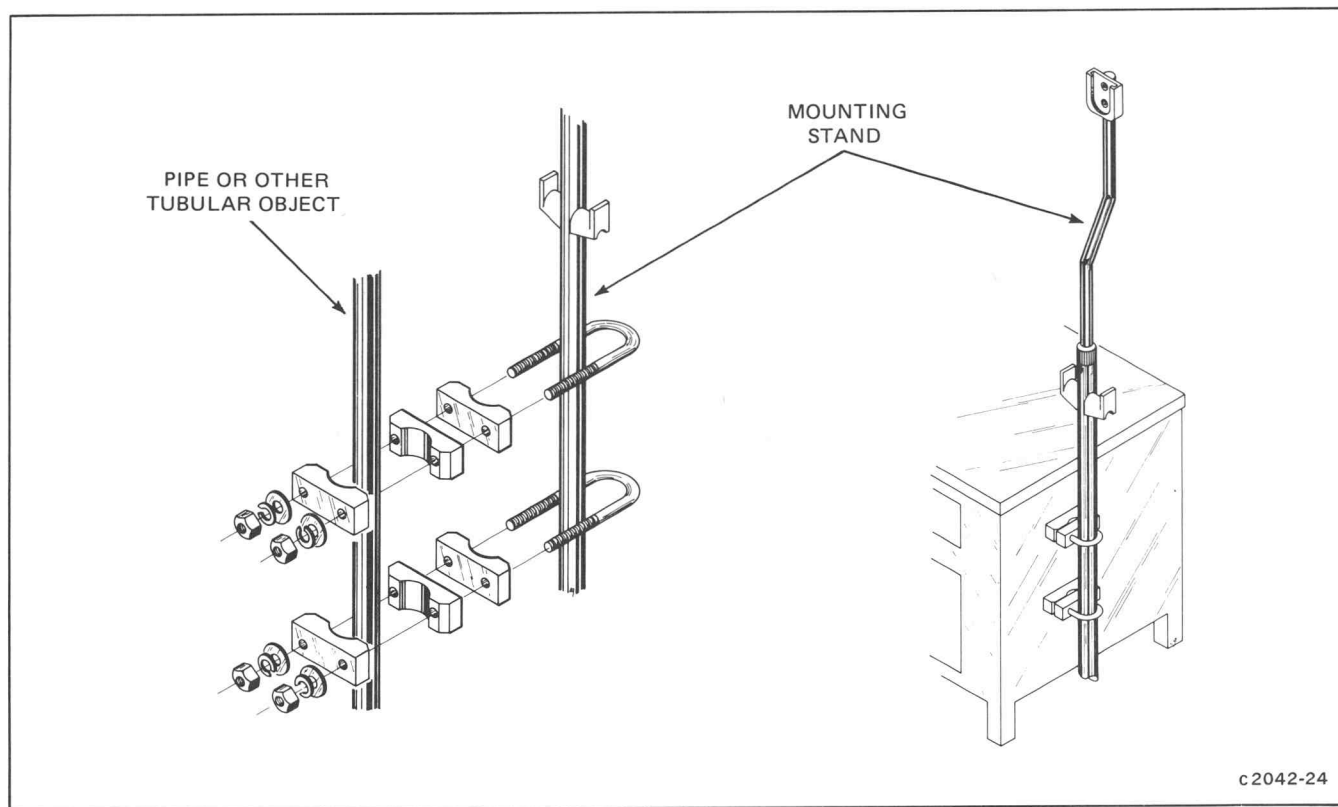


Figure 1-2. Installing mounting stand to tubular object (pipe) or cabinet side.

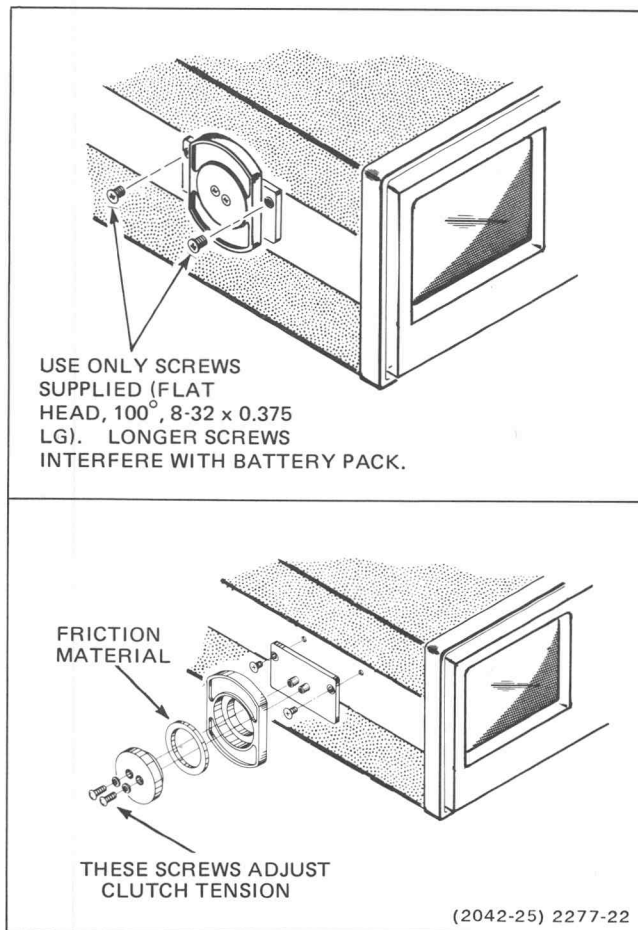


Figure 1-3. Installing mounting adapter to monitor.

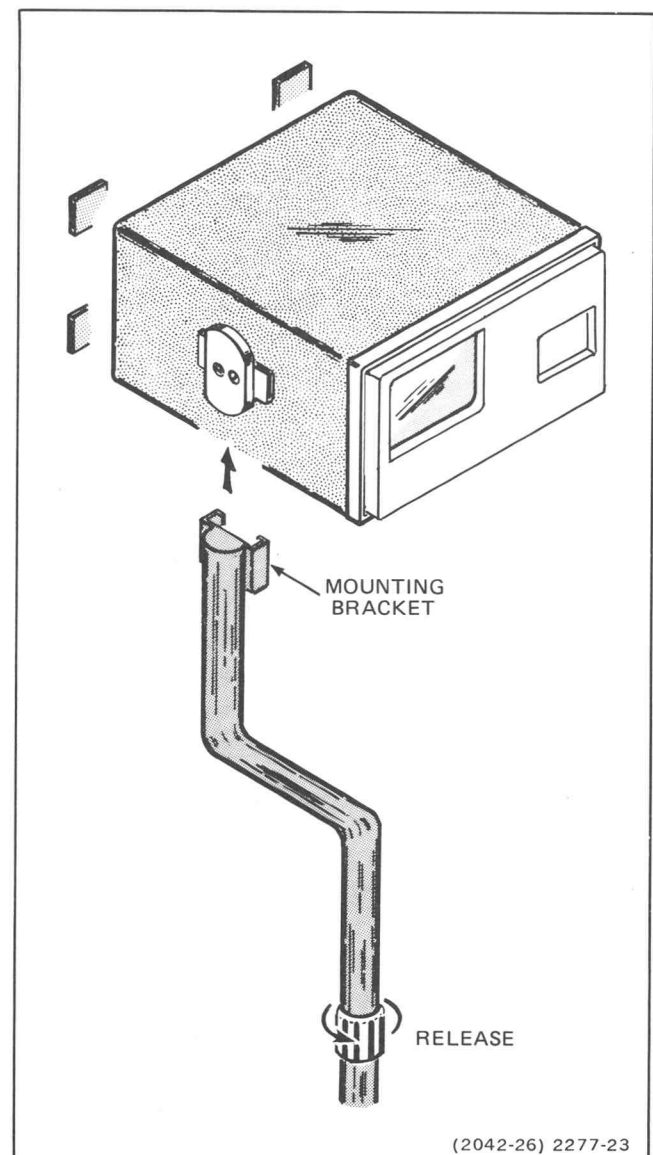


Figure 1-4. Mounting monitor to mounting stand.

ATTACHMENT CABLE DIAGRAMS

Figures 1-5 through 1-9 are hookup diagrams of the various cables and devices associated with the 413 input and output connectors.

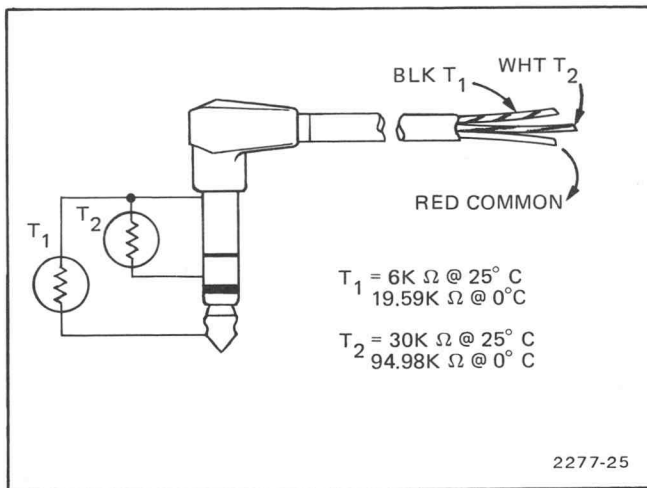


Figure 1-5. Temperature sensor plug.

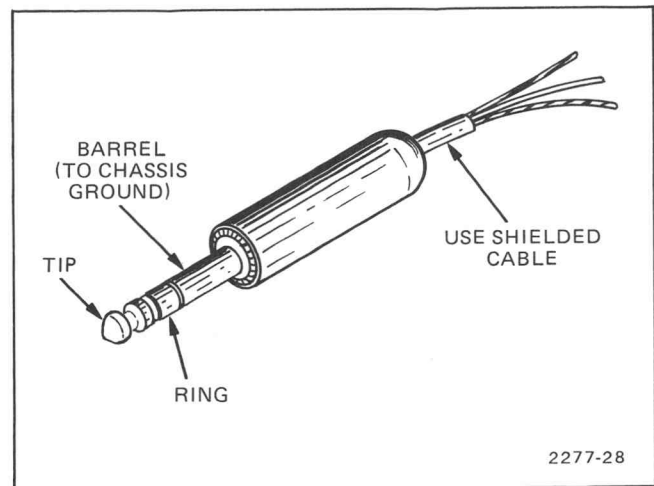
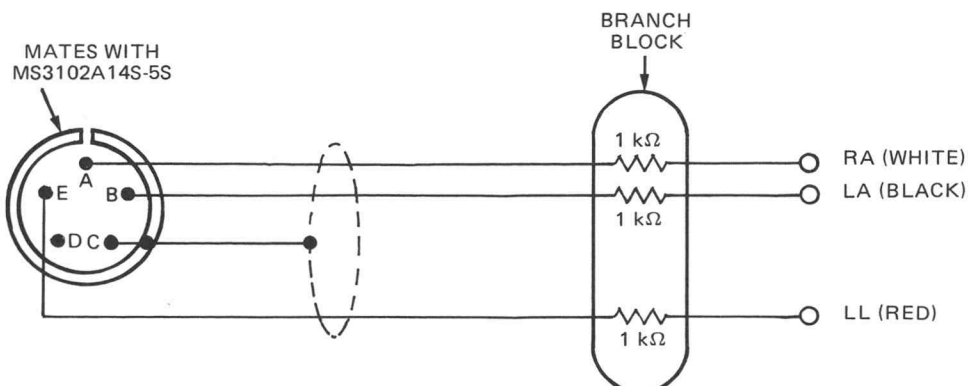
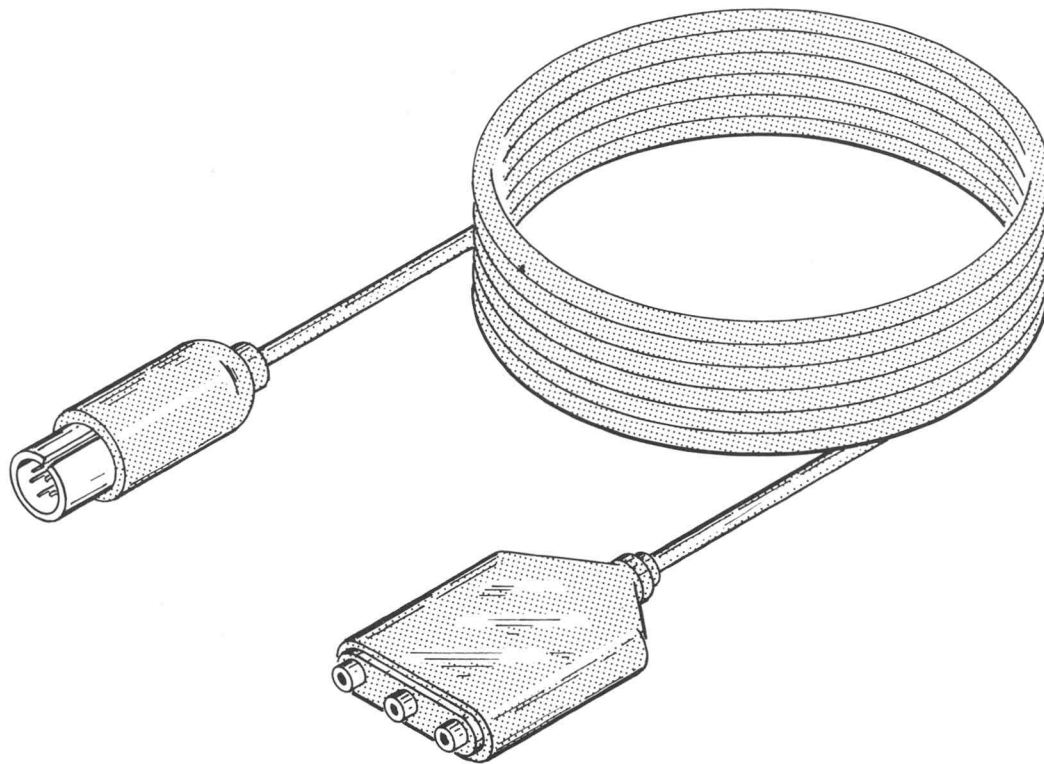


Figure 1-6. Three-circuit 1/4-inch phone plug used for interconnecting signals at rear panel input/output jacks.

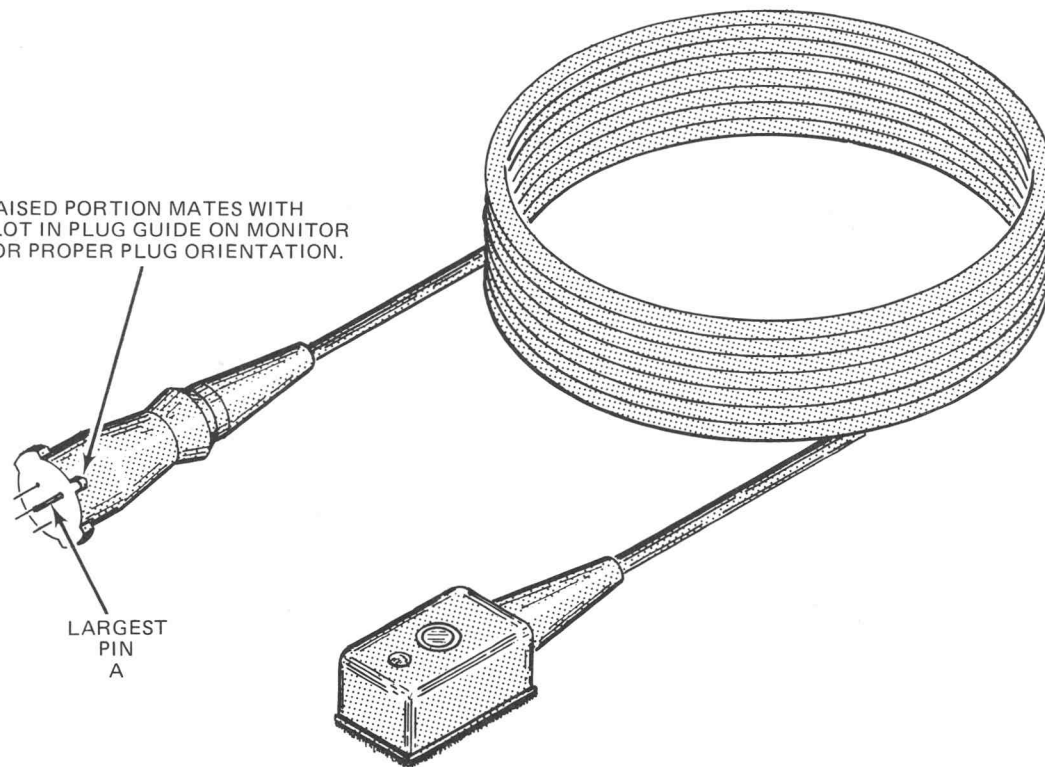


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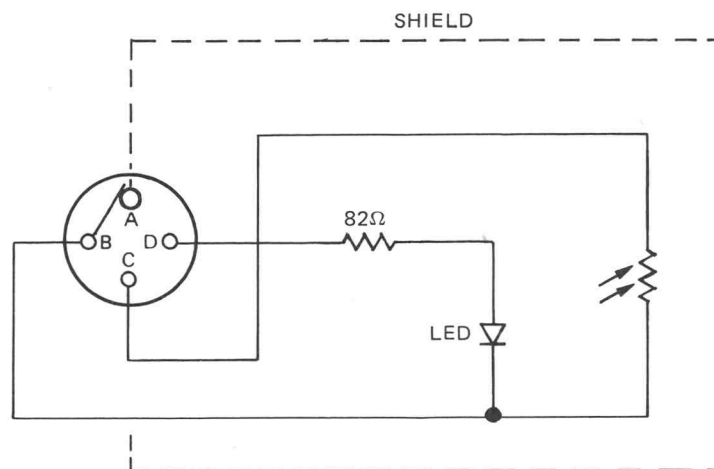
Figure 1-7. ECG/Respiration cable.

RAISED PORTION MATES WITH
SLOT IN PLUG GUIDE ON MONITOR
FOR PROPER PLUG ORIENTATION.

LARGEST
PIN
A



A plug similar to Winchester M4PLSH10C on the pulse sensor cable mates with the Winchester M4SLRN bulkhead connector on the monitor.

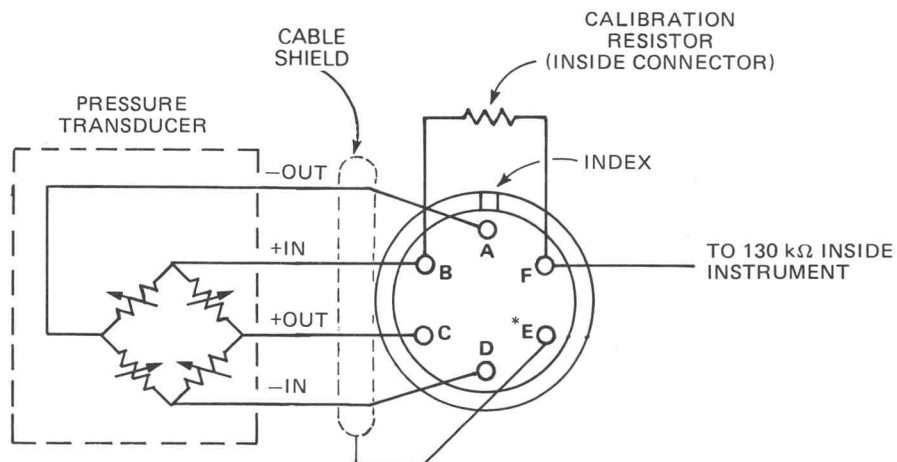
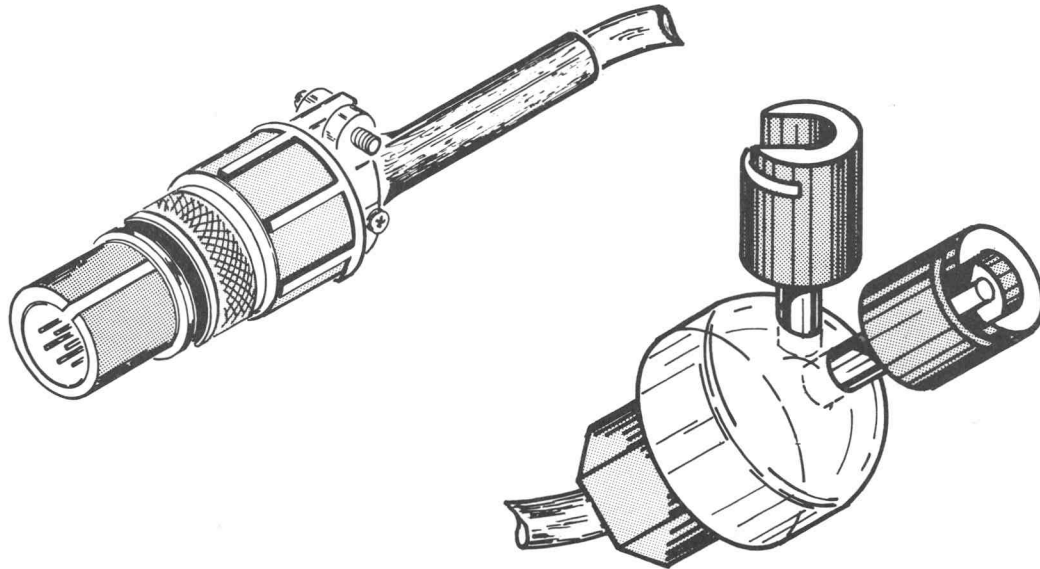


Typical light-emitting diode (LED) with series resistor draws 22 mA at 3.6 V.

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Figure 1-8. Pulse sensor cable.

Plug number MS3106A-14S-6P on the pressure transducer cable mates with the MS3102A-14S-6S bulkhead connector on the monitor. The cable clamp number is MS3057-6A and the bushing number is MS3420-6.



* DO NOT CONNECT CONNECTOR SHELL TO THIS PIN.

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Figure 1-9. Pressure transducer cable.

OPERATING INFORMATION

AC LINE OPERATION

The 413 Monitor is designed for safe ac power-line operation. Battery operation has been provided specifically for mobile monitoring (e.g., during movement of the patient from one location to another). The monitor will operate on an ac power-line regardless of battery pack installation or battery pack charge level.

The monitor is shipped from the factory with the LINE VOLTAGE RANGE switch set at 115 and the correct "Hospital Grade" ac-power plug installed for operation, in the U.S.A., on 115 volt ac power lines.

To change nominal power-line voltage, move LINE VOLTAGE RANGE switch (Figure 2-1) using small bladed screwdriver. Change the ac-power plug to the type approved for the location where the monitor is to be used.

CAUTION

The monitor may be damaged if connected to a 230 volt source with the LINE VOLTAGE RANGE switch set at 115.

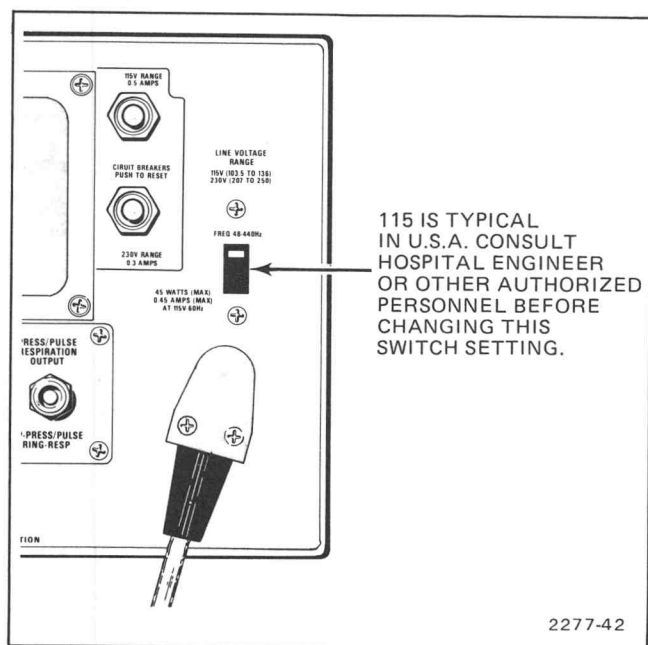


Figure 2-1. Line-voltage switch (rear panel).

AC POWER SOURCE

The 413 is compatible with isolated power systems such as used in operating rooms.

Monitor Operation With Non-Isolated Power Systems

The monitor is intended to be operated from a single-phase earth-referenced power source having one current-carrying conductor (the neutral or grounded conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase-to-phase on a three-wire system) is not recommended, since only the line (or ungrounded) conductor has over-current (circuit breaker) protection within the monitor.

AC POWER CORD AND PLUG

The monitor has a three-wire (18-gauge, SJT-grade) power cord and is normally supplied with a three-terminal polarized plug (Hospital Grade) for connection to the power source and protective ground. The protective-ground (earth) terminal of the plug is directly connected to the frame of the monitor.

WARNING

To avoid electric-shock hazard, insert this plug only in a mating "Hospital Grade" power outlet with a protective-ground contact. Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric-shock hazard. Inspect the power cord periodically for fraying or other damage. Do not operate the monitor from an ac power source if the power cord or plug is damaged.

CIRCUIT BREAKERS

Ac-line circuit breakers are provided as overcurrent protection when operating on 115- and 230-volt lines. When an overcurrent condition has occurred, the red button is extended. Press button to restore the line voltage. If the overcurrent condition persists, have monitor checked by qualified service person.

BATTERY OPERATION

Disconnecting the monitor from the ac line with the POWER switch pushed in (on) will automatically start battery operation. A correctly charged F-cell battery pack provides about 2.5 hours of operating time. The operating time varies with the functions used. See Internal Battery specifications in Section 1, General Information.

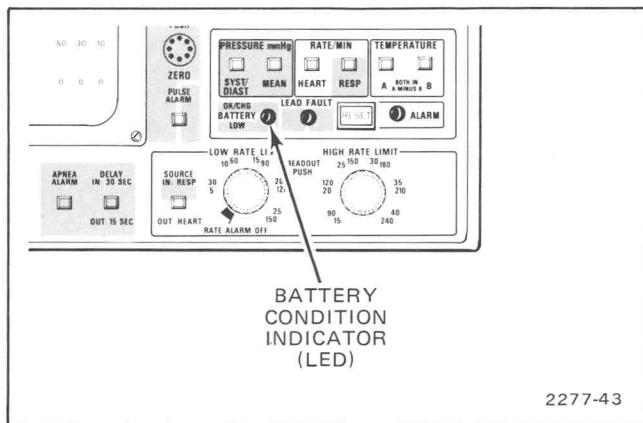


Figure 2-2. BATTERY condition indicator (LED).

BATTERY CONDITION

The color of the BATTERY condition indicator LED (light-emitting-diode, see Figure 2-2) will change between red and green to indicate battery condition. Refer to Table 2-1.

TABLE 2-1

Battery Condition Indicator

Battery Indicator (LED) Color	Battery Condition
Green	Indicates battery is charged (when operating on battery only), or charging when line cord is plugged into ac outlet.
Green and Red (orange hue)	Indicates battery is almost discharged, and approximately 15 to 30 minutes of use time remain.
Red	1. Indicates battery is discharged and monitor is about to shut down (when operating on batteries). 2. Indicates defective battery or charger when line cord is plugged into ac outlet.

The BATTERY indicator does not function with the batteries removed. If the battery fuse (inside the battery pack) has blown, the BATTERY indicator will be on (green) only when the ac power cord is connected.

The monitor will detect a low battery condition and shut off before the calibrated functions deteriorate; however, the monitor will operate on the ac power line regardless of battery condition. Plug the monitor into an ac outlet to use it and recharge the battery pack (see Battery Charging below).

BATTERY CHARGING

Connect ac-power plug into the appropriate ac source to charge the batteries.

Battery characteristics dictate that charging should be done in a temperature range between 0°C and +25°C for the battery to accept the maximum charge.

The greater the temperature above +25°C the less charge the battery will accept. Longer charging time will not compensate for a high temperature. Continuous battery charging is prevented in ambient temperatures above approximately +25°C when the monitor is operating, and above approximately +35°C when the monitor is off.

OPERATING TEMPERATURES

The monitor will operate and meet all specifications over a range of 0° to +50°C.

The monitor will function, but not necessarily meet its specifications over the extended range of -15° to +55°C.

CAUTION

Extended operation below 0°C may reduce the of the gas-discharge digital-display devices.

The monitor may be stored in an environmental temperature range of -40° to +60°C.

A cool monitor taken into a warm, humid environment may cause condensation inside the case. This condensation may create discharge paths on the circuit boards. The monitor should be allowed to dry thoroughly before using. The appearance of condensation on the monitor case is a good indication that moisture may have been drawn into the case.

FUNCTIONS OF CONTROLS, CONNECTORS, AND INDICATORS

Front Panel (Figs. 2-3, 2-4)

- ① **ON.** This pushbutton switch turns the monitor on or off. The battery charger operates continuously as long as the monitor is connected to an ac power source. Continuous battery charging is prevented in ambient temperature above approximately 25°C when monitor is operating, and above approximately 35°C when monitor is off.

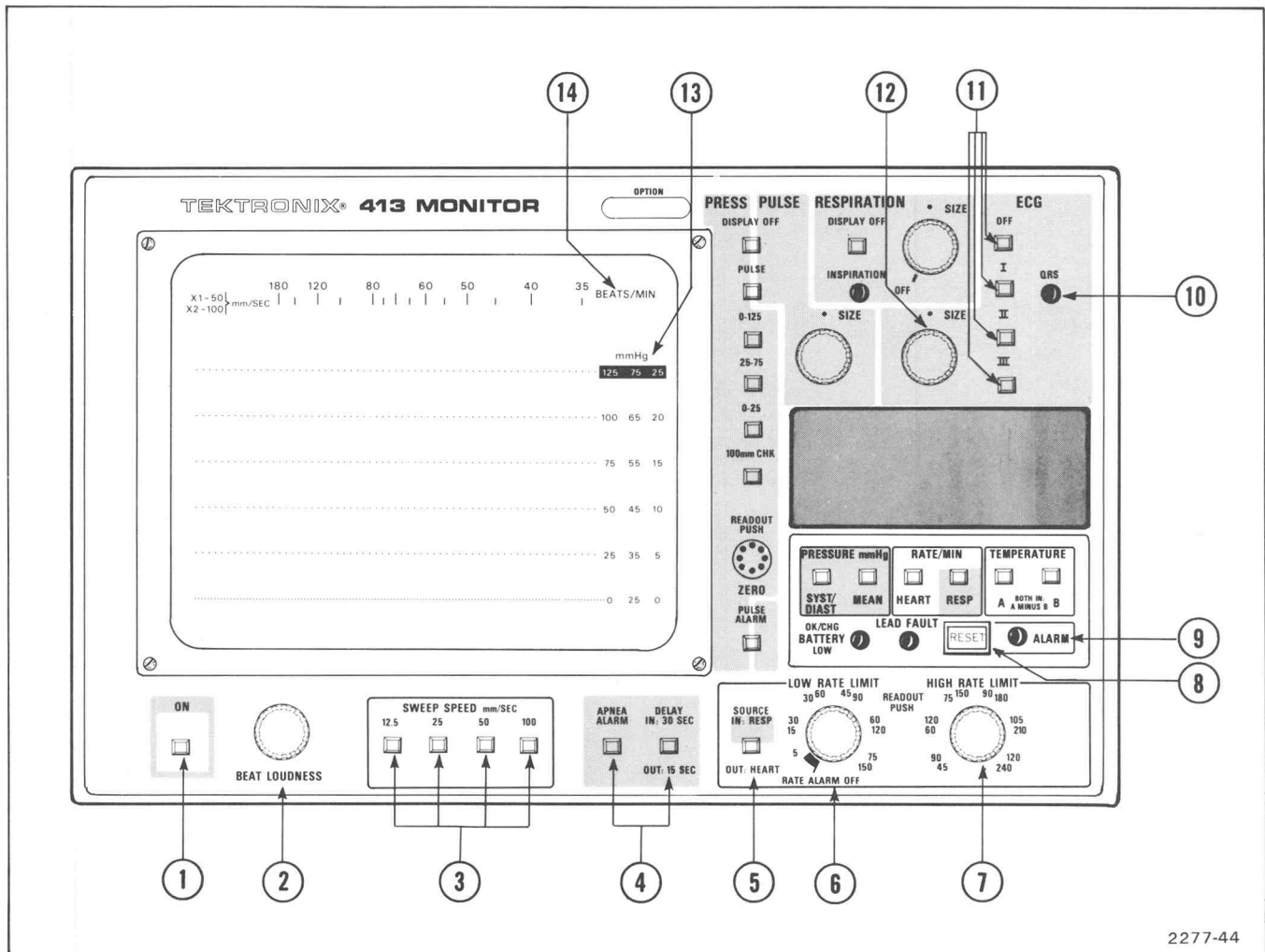


Figure 2-3. Front panel controls and indicators (1 through 14).

- 2 **BEAT LOUDNESS.** This control adjusts the loudness of the beat tone and should be set fully clockwise if maximum loudness is desired. The beat is heard once for each QRS pulse during ECG use, or once for each rising portion of the pulse waveform during pulse operation (or pressure waveform in the pressure mode of operation).
- 3 **SWEEP SPEED mm/SEC.** Four pushbuttons select the speed of the trace across the screen. The sweep speeds are 12.5, 25, 50, or 100 mm/SEC. The total time it takes the trace to cross the screen is 8, 4, 2, or 1 second(s), respectively. The sweep is triggered on 50 or 100 mm/SEC settings only. The trigger source is the ECG channel, when on, otherwise it is the Pressure/pulse channel.
- 4 **APNEA ALARM And DELAY.** Loss of respiration for longer than 15 seconds or 30 seconds activates the alarm when the APNEA ALARM pushbutton is depressed. The alarm is delayed 15 seconds with pushbutton out (released) and 30 seconds with pushbutton in (depressed).
- 5 **SOURCE.** This pushbutton switch selects the RATE ALARM signal source. With the SOURCE switch out (released), the RATE ALARM receives a heart-rate related signal from the ECG channel (only with the ECG channel on). If the ECG channel is OFF, the signal source is from the PRESSURE/PULSE channel. With the SOURCE switch pushed in (depressed), the RATE ALARM receives a respiration-rate related signal from the RESPIRATION channel.
- 6 **LOW RATE LIMIT.** This control sets the lower rate alarm limit between 5 and 75 breaths per minute for respiration, or 30 and 150 beats per minute for heart rate. For more accurate settings, press in the control while adjusting for the desired value on the digital display. This control also disables the RATE ALARM circuit when rotated fully counterclockwise into its detent position.
- 7 **HIGH RATE LIMIT.** This control sets the upper rate alarm limit between 45 and 120 breaths per minute for respiration, or 90 and 240 beats per minute for

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heart rate. For more accurate setting, press in the control while adjusting for the desired value on the digital display.

- 8 **ALARM RESET.** This pushbutton resets the alarm. When an alarm violation occurs, the audible alarm will sound and the indicator will light. Reset the audible alarm by pressing the RESET button. If the condition which caused the alarm persists longer than 45 seconds after being reset, the audible alarm will recur and the RESET button must be pressed again. If the alarm was the result of an acceptable change in patient condition, then press the RESET button and select new RATE LIMITS.
- 9 **ALARM.** This lamp lights (and audible alarm sounds) whenever an alarm condition occurs. Press the RESET button to temporarily silence the audible alarm; the ALARM light will remain on until the alarm violation disappears and the RESET button has been pushed.
- 10 **QRS.** This green LED flashes each time a QRS complex is detected in the ECG.

- 11 **ECG.** Pushbuttons control the lead selection for ECG. They are I (RA to LA), II (RA to LL), and (LA to LL). The four pushbuttons control the display on the upper half of the screen (if any combination of the PRESSURE, PULSE, or RESPIRATION channels are also displayed). If only ECG is on, the display will move to the screen center. The OFF pushbutton turns off the ECG channel.
- 12 **ECG SIZE.** This control varies the height of the ECG waveform display. The rear-panel ECG OUTPUT signal is not affected by the SIZE control.
- 13 **Pressure Scale.** The three pressure scales correspond to the PRESSURE range selected; 0-25, 25-75, or 0-125 mmHg. The vertical portion of the pressure signal is compared to the appropriate scale to determine pressure amplitude in mmHg.
- 14 **BEATS/MIN Scale.** The BEATS/MIN scale is used with the 50 mm/SEC and 100 mm/SEC SWEEP SPEED. The scale shows the correct display multiplier for the sweep speed selected. This scale

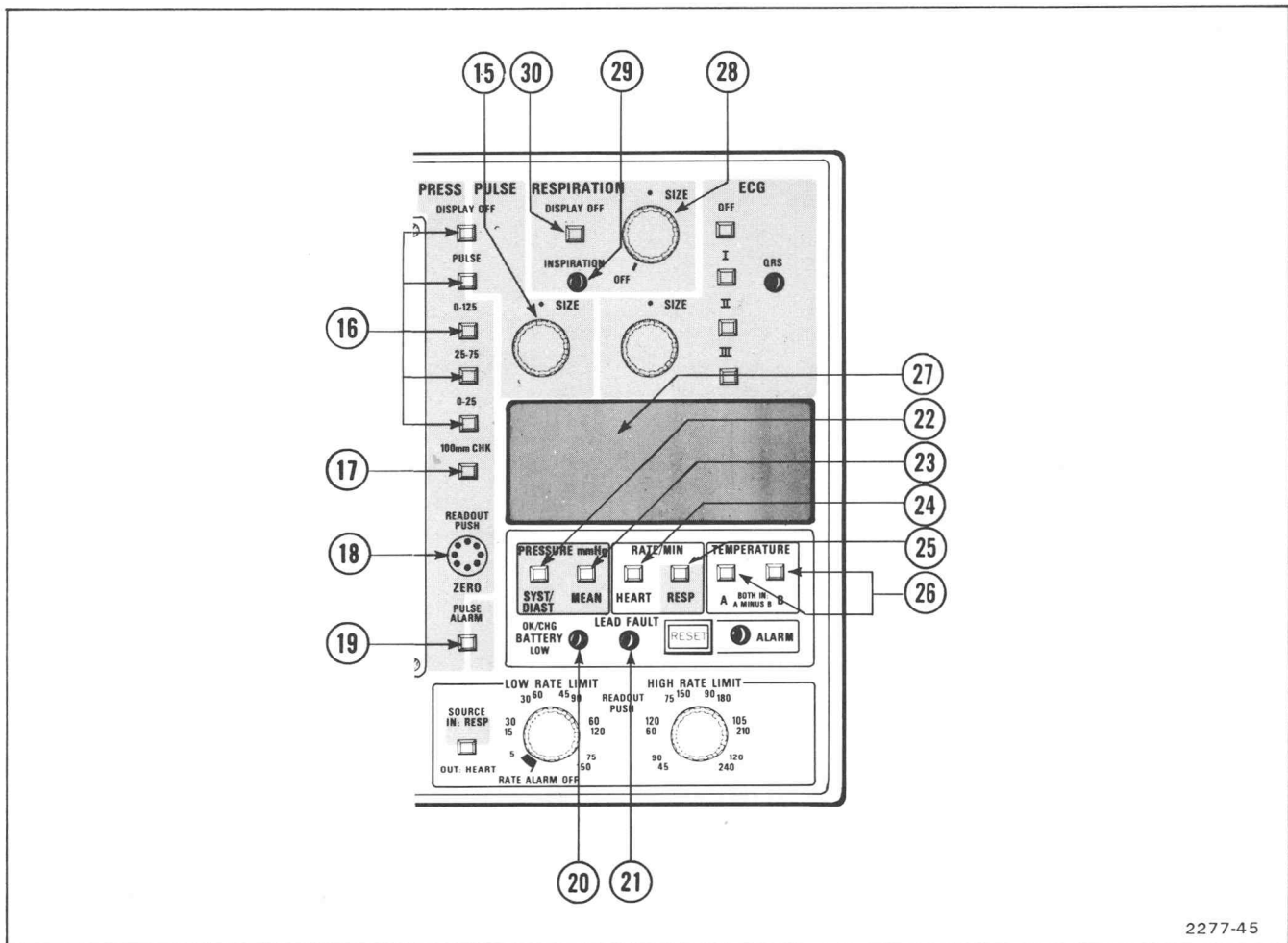


Figure 2-4. Front panel controls and indicators (15 through 30).

is not usable on the 12.5 mm/SEC, or 25 mm/SEC sweep speeds since the sweep is not synchronized at those speeds. At certain heart rates, a spot appears on the left edge of the display. This is the starting point of the sweep, which has been reset and is awaiting the next synchronizing event. Any vertical movement of this spot is an accurate indication of the events prior to sweep start.

- 15 PULSE SIZE.** This control varies the height of the pulse display when the pulse mode of operation is being used. The signal at the PRESSURE/PULSE OUTPUT connector varies in proportion to the displayed pulse signal. Small signals (one-half division of display or less) may not cause a beat tone and may set off the pulse alarm (when the ECG channel is off and the pulse channel is providing the beat information). Display amplitudes that go off the screen may cause extra beats to be heard. Adjust the PULSE SIZE control for a two- to three-centimeter display where possible.
- 16 PRESS/PULSE.** Five pushbuttons control the PRESSURE or PULSE display. They are DISPLAY OFF, PULSE, 0-125, 25-75, and 0-25. DISPLAY OFF turns off the PRESSURE/PULSE waveform display; however, the digital display can monitor the PRESSURE/PULSE channel regardless of the DISPLAY OFF pushbutton setting. PULSE permits the display from a pulse sensor to appear on the screen. The 0-125, 25-75, and 0-25 pushbuttons select the mmHg (millimeters of mercury) range for the pressure display. Small pulsatile pressure signals (one-half division of display or less) may not cause a beat tone. Display amplitudes that go off the screen may cause extra beats to be heard (when the ECG channel is off and the pressure/pulse channel is providing the beat information). Select the appropriate pressure range. Also, see PULSE ALARM control information.
- 17 100 mm CHK.** Usable only with standardized pressure transducers containing a calibration resistor. With such a transducer connected to the monitor, this pushbutton displays a 100 mmHg test signal each time it is pressed (since 100 mmHg is overrange on the 0-25 and 25-75 mmHg pressure scales, the 100 mm CHK button can be used only with the 0-125 mmHg scale). There is no display change when a transducer without a calibration resistor is used. A reading between 95 and 105 mmHg is expected on the digital meter when depressing this button and the ZERO adjustment knob simultaneously. Be careful not to disturb the zero setting while pressing the ZERO adjustment knob.
- 18 ZERO.** This control permits establishment of a zero-pressure reference, and is adjustable with finger tip or screwdriver. Pressing in while rotating the control provides a fast, accurate indication on the digital display.
- 19 PULSE ALARM.** Activates alarm if the pulsatile pressure or pulse signal falls below a certain limit. For pressure, this minimum value is 5-10 mmHg and can indicate a broken, plugged, or dislodged catheter. For pulse, the minimum value is about one-half cm of display and can indicate a loss of peripheral circulation (e.g., in Great Toe during catheterization of femoral artery). Alarm is inhibited when switch is in the out position.
- 20 BATTERY.** This LED (light emitting diode) changes color from green to orange to red to indicate the approximate state of charge of the battery pack. Refer to Table 2-1 on page 2-2.
- 21 LEAD FAULT Indicator.** This LED responds to information from either ECG or Respiration channel. Activation from ECG channel indicates loss of effective ECG amplifier input connection to patient. Activation from Respiration channel indicates unsuitable condition in LA to RA lead/electrode system for respiration monitoring. the following possible problems:

 - a. An open circuit (break) in the patient cable, the electrode wires, or the electrodes.
 - b. Poor contact to patient due to insufficient gel or paste on the electrode(s).
 - c. One or more electrodes or electrode attachment wires disconnected.
 - d. No button pushed in on the ECG switches.
 - e. Two or more buttons pushed in on the ECG switches.
 - f. Excessive dc offset due to dissimilar metals, etc., between the electrodes.
- 22 SYST/DIAST.** Digital readout display alternates between systolic and diastolic readings expressed in millimeters of mercury (mmHg). The complete readout cycle takes about 3 seconds; the PRESSURE/PULSE DISPLAY OFF pushbutton can be in or out.
- 23 MEAN.** Digital readout displays arithmetic mean of pressure signal in mmHg. The PRESSURE/PULSE DISPLAY OFF pushbutton can be in or out.
- 24 HEART RATE/MIN.** Digital readout displays heart rate in beats per minute. Signal source is ECG when ECG is on. When ECG is off, either pressure or pulse provides the rate information.

- 25 **RESP RATE/MIN.** Digital readout displays respiration rate in breaths per minute. Signal source is from RESPIRATION channel.
- 26 **TEMPERATURE.** Select either the A or B temperature probe for individual temperature readout displays. Press both A and B pushbuttons together for a difference readout display. Display temperature in °C or °F as selected by the rear-panel switch. Resolution is 0.1°. Use only dual-thermistor Yellow Springs Instrument Co. 700 series probes.
- 27 **Digital Display.** Provides digital display of pressure (mmHg), heart rate (beats per minute), respiration rate (breaths per minute), temperature (°C or °F), rate limits setting, or pressure ZERO adjustment knob setting. Polarity is indicated automatically to aid in setting of transducer zero and for reading vacuum. Readout display flashes to indicate overrange, and is blanked if the function selected is invalid or if all the pushbuttons are out.
- 28 **RESPIRATION SIZE.** This control varies the height of the respiration display when the RESPIRATION mode of operation is being used. The RESPIRATION mode can be disabled by rotating the SIZE control fully counterclockwise into the detent (OFF) position.
- 29 **INSPIRATION.** This yellow LED lights when chest expands with each draw of breath and can also be seen on the respiration waveform display as the rising portion of each wave.
- 30 **RESPIRATION DISPLAY OFF.** Turns off the RESPIRATION waveform display; however, the digital display will monitor the respiration rate (with RESP pushbutton depressed) regardless of the DISPLAY OFF pushbutton setting.

Side Panel (Fig. 2-5)

- 31 **ECG LEAD CHECK.** These three terminals provide a test signal for checking cable defects, electrode wire defects, circuit operation, and QRS detector function. When the patient wires are connected to the ECG LEAD CHECK terminals, an ECG lead selector button is pushed in, and the ECG SIZE control is centered (on midrange mark), the display should be:

Lead Display

- I 2 centimeters of positive-going signal.
- II 3 centimeters of positive-going signal.
- III 1 centimeter of positive-going signal.

If the LEAD FAULT LED lights, the cable or electrode wires may be defective.

Rear Panel (Fig. 2-6)

- 32 **ALARM LOUDNESS.** Adjusts the loudness of the audible alarm signal. Set fully clockwise if maximum loudness is desired. Audible alarm will be turned completely off if control is fully counterclockwise.
- 33 **TEMPERATURE SENSOR INPUTS.** Connect only Yellow Springs Instrument Co. 700 series dual-thermistor temperature probes. The two temperature inputs may be utilized individually (INPUT A or B) for separate temperature measurements, or together (both INPUTS A and B) for difference temperature measurements, as selected on the front panel.
- 34 **°C/°F.** Switch selects temperature scale for both temperature channels.
- 35 **GND.** Provides an additional grounding point (there is one in the power cord) for the instrument case. When the power cord is not connected to a power source, the case should be grounded using the GND. This provides added protection against any voltage source which may contact the case, reaching the patient. Grounding through the power cord requires an appropriate three-wire outlet. Do not use a three-terminal to two-terminal adapter. See "Grounding" in the Safety Information section.
- 36 **ECG/RATE OUTPUT.** Provides two output signals through a stereo phone jack. The tip is the ECG signal times 1000 gain. The ring is a heart rate trigger signal. The heart rate trigger signal amplitude is +5.5 volts at 12 milliamperes with a duration of approximately 68 milliseconds.
- 37 **ALARM.** Provides for remote indication and resetting of alarms through a stereo phone plug. Shorting the phone plug tip to the barrel (ground) resets the alarm (providing the alarm violation has been corrected). The ring provides a 12 mA signal to indicate an alarm condition.
- 38 **PRESS/PULSE RESPIRATION OUTPUT.** Provides two output signals through a stereo phone plug. The tip provides a pressure/pulse output of 0.5 volt for each centimeter of displayed signal. The ring provides a respiration signal output of 0.5 volt per centimeter of displayed signal on the screen.
- 39 **AC Power Cord and Plug.** Permits connection to the power line for ac operation and battery charging.

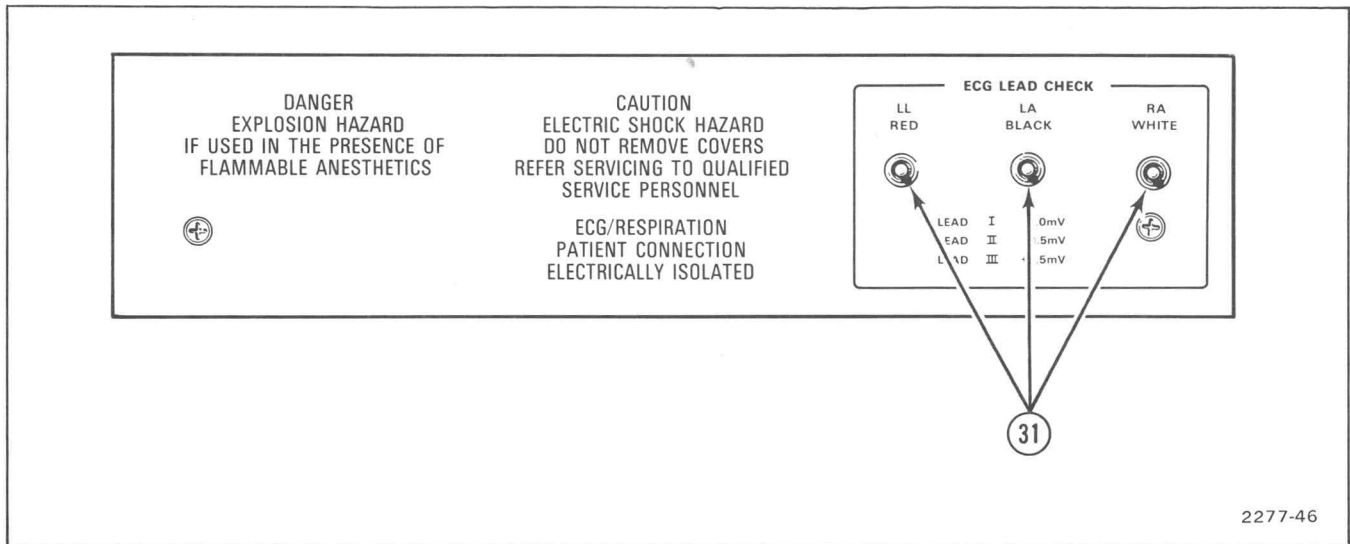


Figure 2-5. Side panel ECG LEAD CHECK terminals.

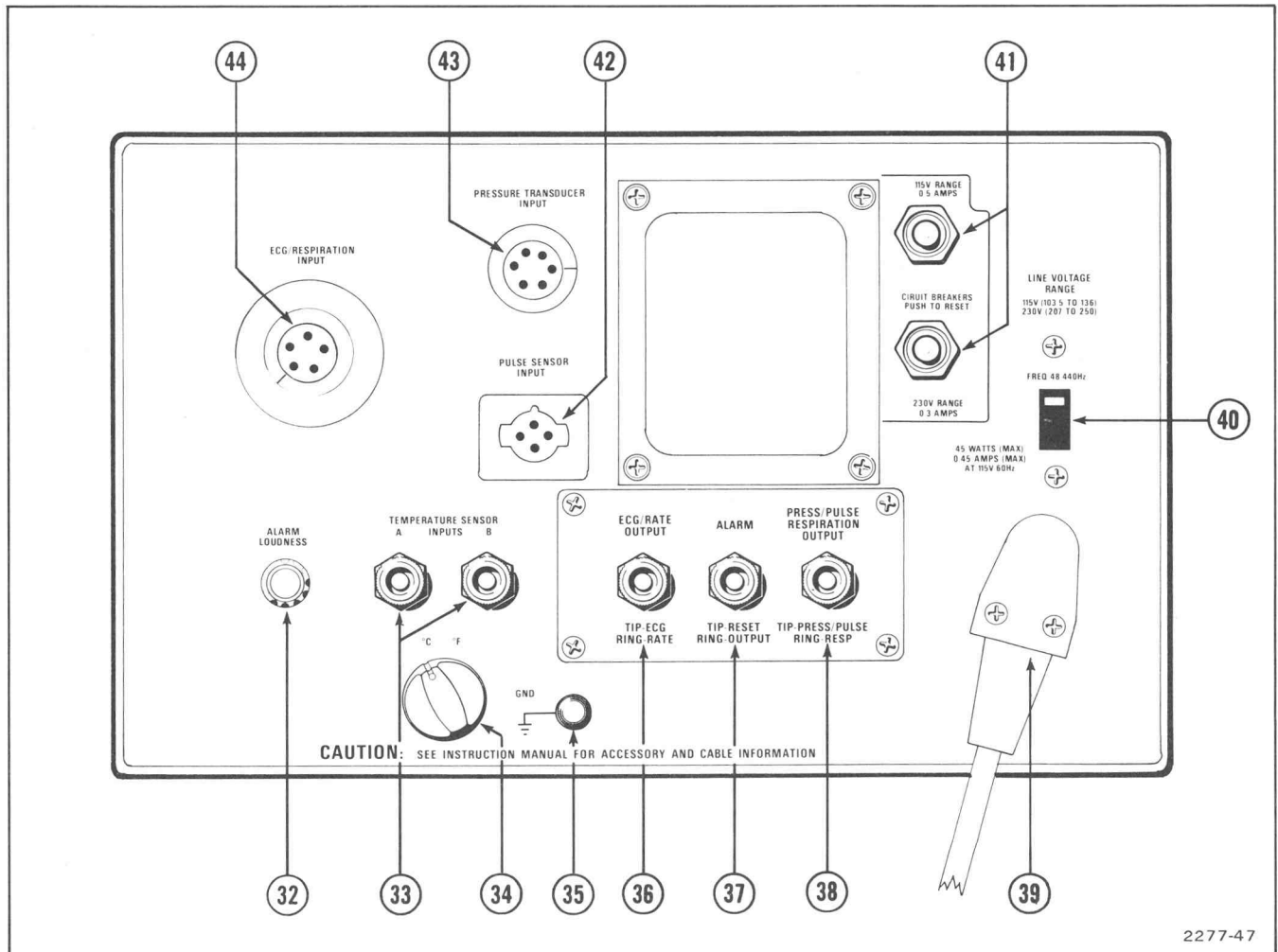


Figure 2-6. Rear panel controls and connectors.

40 LINE VOLTAGE RANGE. This switch is a screwdriver-operated slide switch. It must be set to indicate the proper ac power-line voltage range (115 or 230 V ac).

41 CIRCUIT BREAKERS. Provides line-voltage circuit breakers to protect the instrument under fault conditions. The LINE VOLTAGE RANGE switch automatically selects the appropriate circuit breaker (115 or 230 V ac). Press the extended button to restore the line voltage.

42 PULSE SENSOR INPUT. Permits connection of the pulse sensor cable to the instrument.

43 PRESSURE TRANSDUCER INPUT. Permits connection of the pressure transducer cable to the instrument.

44 ECG/RESPIRATION INPUT. Permits connection of the patient cable to the instrument.

THEORY OF OPERATION

This section describes the operation of the circuits in the 413 Monitor.

In general, most circuitry is confined to 10 circuit boards. The Main board, which is the largest, is mounted horizontally on the lower part of the monitor and contains the Trace Chop Multi, Vertical Amplifier, Sweep Trigger, Sweep Generator, Horizontal Amplifier, Audio Amplifier, Power Supplies, and Battery Charger circuitry. Five boards (ECG, Respiration, Pressure/Pulse, DVM, and High-Voltage) are plugged on top of the Main board. The Conditioner board is plugged on the bottom of the Main board. The remaining three boards (Readout Switch, Sweep Switch, and Display) are mounted to the front subpanel.

The QRS-beat and alarm speaker is located inside the left-side frame, near the front of the monitor. The power transformer, with all other ac-line-voltage circuitry, is mounted to the rear panel.

The Functional Block Diagram, in the Diagrams and Circuit Board Illustrations section, shows major circuit and signal flow and can be used to get a general overall understanding of circuit relationships. Detailed schematics of each circuit are also located in the Diagrams section at the back of this manual. Refer to these schematics throughout the following circuit description for specific electrical values and relationships.

ECG BOARD

ECG BOARD CIRCUIT FUNCTIONS

The ECG circuit (Figs. 3-1 and 3-2) accomplishes the following:

1. Amplifies the ECG signal (three input lead configurations). The circuit provides extremely low-leakage isolation (less than 5 μ A rms at 120 V ac 60 Hz) between patient and monitor. The input circuitry is protected for use during defibrillation and electrocautery.
2. Indicates when a fault exists in ECG input cables, wires electrodes, etc.
3. Provides ECG output signals to a rear-panel jack. Output amplitude is fixed at X1000 of the input signal.
4. Provides an amplified ECG display signal, whose amplitude is variable with the ECG SIZE control. When only the ECG channel is on (single trace), the display baseline is positioned to the screen center. When the pressure/pulse and/or respiration channel is also displayed, the ECG display baseline is positioned about 2 centimeters above the screen center.
5. Provides a logic signal to indicate whether the ECG channel is off or on. The signal goes to:
 - a. The Main board to allow display of this channel either in single or multi-trace depending on the status of the pressure/pulse or respiration channels.
 - b. The Main board to select the trigger source, either from the ECG channel (ECG on) or from the pressure/pulse channel (ECG off).
 - c. The Pressure/Pulse board to set the pulse display baseline at the screen center for pulse only, or about 2 centimeters below screen center when both pulse and ECG are selected.
 - d. The Respiration board to set the respiration display baseline at the screen center, 2 centimeters below screen center, or 2 centimeters above screen center, depending on the status of the ECG, pressure, or pulse channels.
6. Provides an ECG (QRS) trigger to the Main board for digital display of heart rate, sweep triggering, beat tone, analysis of heart rate alarm conditions, and to the RATE OUTPUT connector on the rear panel.

ECG AMPLIFIER CIRCUIT OPERATION

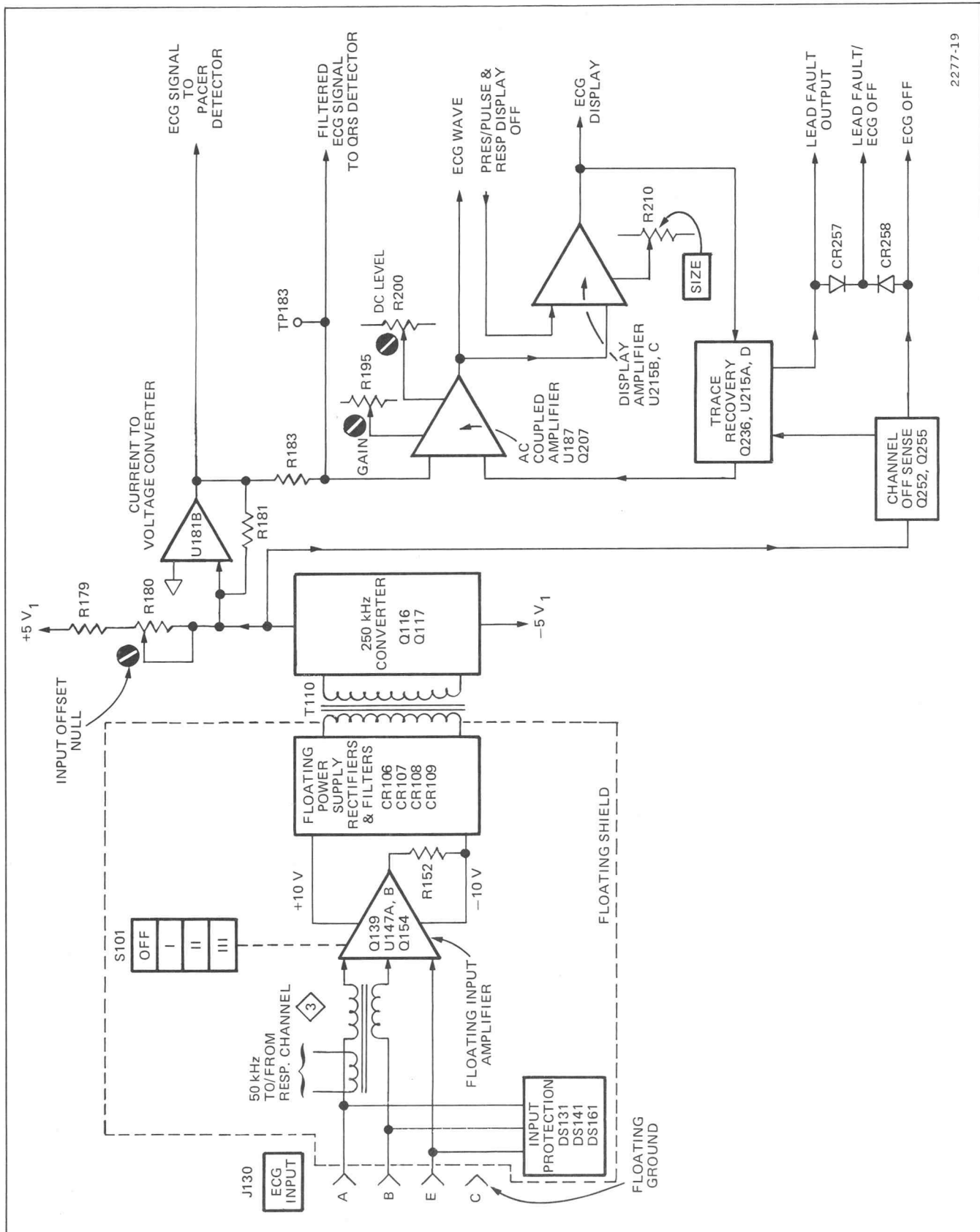
The ECG signal enters the Floating Input Amplifier (Fig. 3-1) through three electrode wires. One of the wires is the signal reference and the other two are used for a differential input signal. The ECG pushbuttons are used to select any pair of wires as the input signal. Respiration signal is picked off through T162 from leads RA and LA.

The ECG patient cables contain a resistor in series with each input wire. These resistors, and the input protection circuit, protect the Floating Input Amplifier during defibrillation and electrocautery.

A very small amount of current (1 nA) is injected into the patient electrodes. When this current is interrupted in any input wire (as when a wire breaks), the LEAD FAULT indicator lights.

The input amplifier is isolated from the other circuitry and from the monitor chassis. The shield covering the Floating Input Amplifier circuitry and the shield in the patient cable are connected to the floating ground point to reduce ac interference.

The Floating Power Supply and 250 kHz Converter provides the power for the Floating Input Amplifier through transformer T110. The circuit is designed so that the amplified ECG signal varies the load on the transformer, causing the supply current to change. This changing current becomes an amplified voltage signal at the output of the Current-to-Voltage Converter.



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The Current-to-Voltage Converter provides ECG signals to the Pacer Detector and QRS Detector, and the input signal to the Ac-Coupled Amplifier.

The Ac-Coupled Amplifier provides the remainder of the needed gain and determines the high- and low-frequency response of the ECG channel. Gain and dc level are set by the two calibration adjustments in this circuit. Output of this amplifier provides the ECG output to the rear panel and the input to the Display Amplifier.

In the Display Amplifier, ECG-display-signal amplitude can be varied with the SIZE control. This control does not change the ECG-output-signal amplitude to the rear panel. A logic signal, from the Pressure/Pulse board, positions the ECG-display baseline for single or multi-trace operation.

250 kHz Converter

This circuit consists of Q116, Q117, a transformer (T110), and a rectifier-filter circuit. The Converter produces an approximate 250-kHz trapezoidal wave. The frequency is dependent upon the load on the Converter. Transformer T110 is insulated for at least 5 kV.

Floating Input Amplifier

Circuit protection is provided against excessive input voltages to the input amplifier during electrocautery and defibrillation. Input voltage is limited by DS131, DS141, DS161, R136, R166, CR135, CR136, CR165, CR166,

VR145, VR146 and the 1 k Ω resistors in the patient cable. Capacitors C131, C141, and C161 reduce radio-frequency interference from TV and radio signals and electrocauterizers. Resistors R136 and R166 also provide patient protection in case of circuit failure. Resistors R135 and R165 supply about 1 nanoampere of current to the patient electrodes. If this current is interrupted (wire breaks or high electrode resistance), the display will shift off screen and the LEAD FAULT indicator will light.

The input Amplifier is a differential-input, single-ended output circuit consisting of balanced transistors Q139A and Q139B and output amplifier U147B. The output of U147B varies the current through R157 in proportion to the ECG input signal. The differential gain of the amplifier is determined by feedback dividers R151/R153 and R157/R158. The gain at TP151 is about 9.5 times the input signal.

U147A maintains the junction of R153 and R157 at 0 volts (referenced to the floating ground), which permits R156 to set a constant current through Q139A and Q139B, reducing the ac common-mode signals to a very low level.

When no signal is applied, there should be about 0 volts at TP151 and at the junction of R153 and R157. Under this condition, R152 current is about 5 mA.

R152 current comes from the +10V supply, through U147B and to the -10 V supply. When a signal enters the input amplifier, the current through R152 increases or decreases changing the load on the 250 kHz Converter.

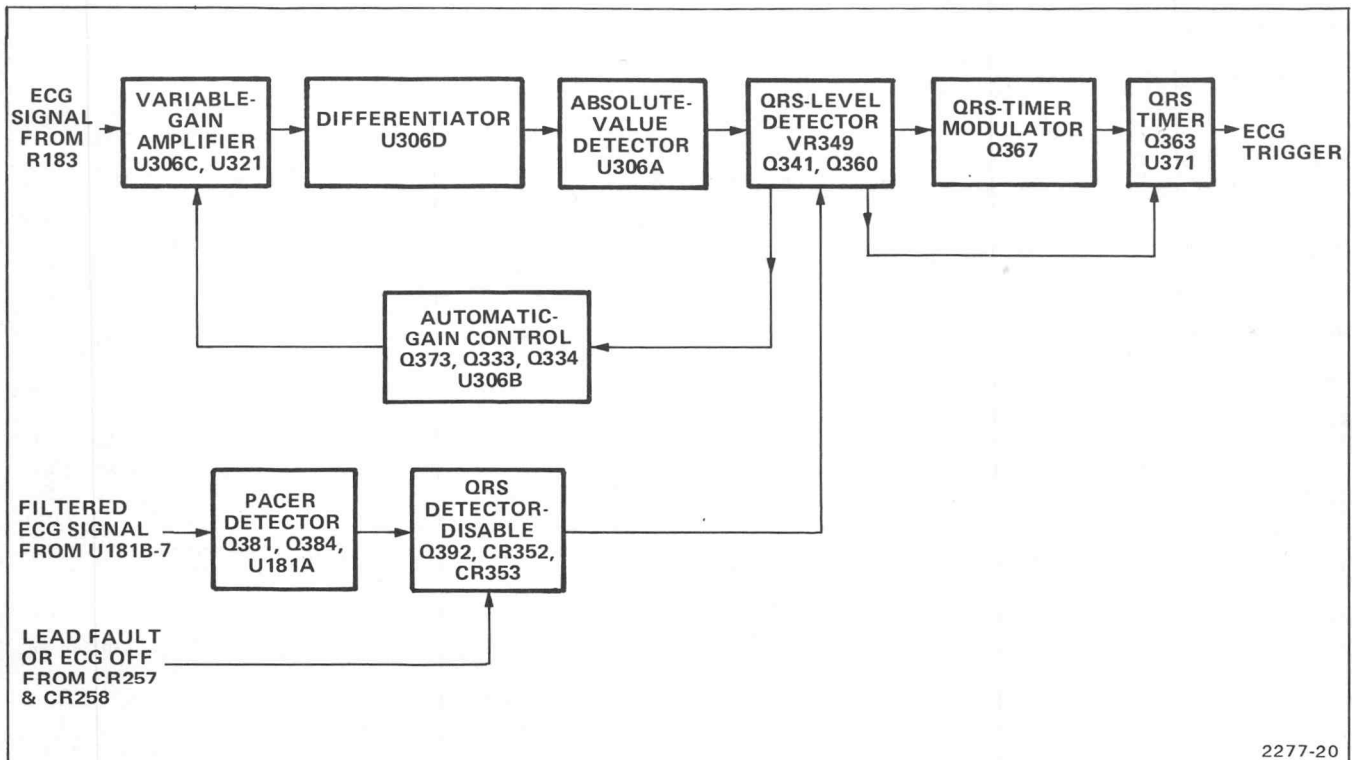


Figure 3-2. QRS Detector block diagram.

Current to Voltage Converter

Feedback action of U181B maintains 0 volts at pin 2 of T110, by way of R181. Input Offset Null (R180) is adjusted so that pin 2 of T110 is 0 volts when no signal is applied to the ECG INPUT.

The ECG input signal thus varies the current in the 250KHz Converter. Since the current through R180 and R179 is constant, the current through R181 will change. The changing current in R181 is produced by a voltage at the point of U181B that is 20 times the ECG input signal. The gain is determined by the Floating Input Amplifier gain at TP151, the turns ratio of T110, and the ratio of R181 to R152.

R183 and C183 filter most of the inverter hash from the signal. Remaining hash is removed by the Ac-Coupled Amplifier.

Ac Coupled Amplifier

U187 and associated circuitry make up a special form of non-inverting amplifier with upper and lower bandwidth limits.

Short-duration overdrive signals will not shift the display baseline significantly because ac-coupling capacitor C202 is in the feedback circuit. The matched field-effect transistors Q207A and Q207B are connected as a source follower and raise the load impedance to the ac-coupling network, R203, R204, and C202.

The X50 amplifier gain is determined by R187, R186, R194, R195 (Gain) and R197. High-frequency bandwidth is determined by R187, R186, and C192.¹ Low frequency bandwidth is determined by C202, R203, and R204.

R187 and R186 limit the input dynamic range of the amplifier to ± 7.5 V, corresponding to a ± 375 mV dc offset at the ECG INPUT connector. This allows the LEAD FAULT indicator to be on when the input dc offset exceeds the ± 375 mV limit.

Display Amplifier

The X1000 ECG signal from pin 1 of U187A goes to the Display Amplifier, which consists of U215C and U215B. U215C is an inverting operational amplifier with R206, R210, and R226 making up the gain-determining divider. The SIZE control R210 varies the gain approximately from X1/3 to X3 with X1 gain at R210 mechanical center.

U215B is an inverting operational amplifier with a gain of 1/2. R231 and R223 set the dc level of the ECG signal depending upon the status of the pressure/pulse channel as detected at the cathode of CR223.

Trace Recovery & Lead Fault

The Trace Recovery circuit speeds up the return of an off-screen signal. When the dc level at pin 1 of U215A exceeds ± 1.0 V (corresponding to ± 4 centimeters on the

screen), Q236 conducts, shunting R236 across R203/R204 to speed the charging of C202 in the Ac-Coupled Amplifier.

U215A, CR244, and CR246 act as a full-wave rectifier so that Q236 will turn on regardless of the polarity at pin 7 of U215B.

C238 delays Q236 turn-on so that short-duration overdrive signals (such as pacer signals) will not affect Q236 and the lead-fault circuits. C238 also delays Q236 turn-off to allow the recovery action to return the trace to its quiescent level.

When the ECG input dc offset exceeds about ± 375 mV, the LEAD FAULT LED (light-emitting-diode) lights. When the ECG channel is off, a positive signal through CR249 keeps the LEAD FAULT LED turned off. A high signal through CR257 disables the QRS detector when the LEAD FAULT LED is on.

Channel Off Sense

This circuit consists of Q252 and Q255 which provides a logic signal to indicate whether the ECG channel is on or off.

When the ECG channel is off, the voltage at the base of Q252 is positive, which produces a 7-volt HI signal at the collector of Q255. This HI (off) signal keeps the LEAD FAULT LED off and also goes to the Pressure/Pulse, Respiration and Main boards to establish single or dual-trace conditions (when the pressure/pulse and/or respiration channel is on).

+5 V and -5 V Supplies

These supplies provide power to the 250 kHz Converter and Input Offset circuitry. The +5 V_I current is supplied from the +7 V supply thru Q291; the -5 V_I current is supplied from the -7 V supply thru Q297. The regulated +5 V from the power supply provides the reference voltage, non-inverted thru amplifier U291A/Q291 for +5 V_I, and inverted thru amplifier U291B/Q297 for -5 V_I.

QRS DETECTOR CIRCUIT OPERATION

The QRS Detector (Fig. 3-2) evaluates the content of the incoming ECG signal to determine when the QRS portion of the waveform occurs. The QRS segment has at least one slope which has a greater rate of voltage change for a longer period of time than other segments of the ECG waveform. When a QRS segment is detected, an ECG trigger pulse is generated that triggers the sweep and heart-rate beat tone, and supplies rate information to the rate-limit alarm circuits.

The ECG signal passes through the Variable-Gain Amplifier, the Differentiator, and a full-wave rectifier (Absolute-Value-Detector). The resulting positive signal contains one or more large, relatively wide, essentially sinusoidal pulses for each QRS segment at the input. Feed back through the Automatic-Gain Control circuit maintains pulse amplitude at about 3-4 volts.

¹For diagnostic bandwidth of 0.05 Hz to 100 Hz, P187 can be removed. This disconnects C199 and R204 from the circuit.

Those portions of the pulses over 1 volt pass through the QRS Level Detector to the QRS Timer. The first pulse greater than 5 ms that enters the QRS Timer circuit produces the ECG Trigger. Any other input pulses (i.e., pulses caused by T-waves) which occur in less than 150 ms after the first pause, are ignored.

The Pacer Detector circuit prevents pacer signals from producing a QRS trigger signal by shutting off the ECG signal in the QRS Level Detector circuit during the pacer pulse. Lead Fault and ECG Off signals also prevent ECG triggers.

Variable Gain Amplifier

U306C is a non-inverting operational amplifier. Variable-gain feedback to U306C is provided through the operational transconductance amplifier U321. The gain of the operational transconductance amplifier varies in direct proportion to the current into pin 5 and the value of R321. The Automatic Gain Control circuit varies the current of pin 5 of U321 from 3 to 300 μ A. A current of 300 μ A into pin 5 sets the gain of U321 to 100, and the over all gain of the Variable Gain Amplifier to 1. A current of 3 μ A into pin 5 sets the gain of U321 to 1 and the overall gain to 100.

The RC combination of R321/C321/C322 provides a low-frequency rolloff of about 1 Hz.

Differentiator and Absolute Value Detector

Signals from the Variable Gain Amplifier at TP306 are differentiated and inverted through U306D. The differentiated signal is then full-wave rectified through CR317 for the rising portion, and through U306A (X1 inverting amplifier) and CR316 for the falling portion. This full-wave rectifier action produces (at TP317) two positive-going pulses for each positive or negative-going pulse into U306C, one pulse for the rising portion and the other for the falling portion.

QRS Level Detector

The base of Q360 is set at +1 volt so that pulses at TP317, which are +1 volt or greater, pass through CR354 to the QRS Timer. The base of Q341 is set at +3 volts so that pulses at TP317, which are +3 volts or greater, pass through CR351 and turn on the Automatic Gain Control circuit.

QRS Timer

When the QRS Level Detector detects a pulse over 1 volt, from TP317, Q360 turns on causing Q363 to turn off. (Prior to this, Q363 was saturated and C363 was discharged.) When Q363 is turned off C363 starts charging toward -7 volts. After about 5 milliseconds (depending on the action of Q367 and associated circuitry), pin 2 of U371 reaches the lower threshold point (about -2.3 V), causing pin 3 to go HI to produce the leading edge of the ECG Trigger. When U371 switches, pin 7 is released and C371 starts charging

towards +7 volts. When pin 6 of U371 reaches the upper threshold point (about +2.3 V), pin 3 goes LO. The ECG trigger pulse at TP371 has a duration of about 150 milliseconds.

QRS Timer Modulator

Q367 provides noise immunity for the ECG trigger circuitry. If considerable 60 Hz or other noise is present, C363 charge time will be lengthened to a maximum of 8 milliseconds to prevent U371 from triggering on the noise. If the noise level is low, C363 will charge at the normal rate (about 5 milliseconds).

Automatic Gain Control

When a pulse at TP317 is 3 volts or greater, Q341 turns on, Q333 and Q334 turns on, and the current into pin 5 of U321 is increased. The increase in current into U321 increases the negative feedback in U306C and decreases the gain.

If a QRS signal is not present for several seconds, pin 3 of U371 remains LO and cuts off Q373 long enough for C373 to charge and turn on CR343. This quickly reduces the current through Q333 and Q334 and increases the gain of the Variable Gain Amplifier to maximum. When the QRS signal returns, VR349 conducts through R349 to rapidly reduce the gain to normal.

When the ECG signal at TP306 exceeds + or -7 volts, pin 7 of U306B goes HI and turns on Q334 harder. This decreases the gain of the Variable Gain Amplifier and provides greater current output from U321 to charge C321-C322 to accommodate any dc level changes at TP183.

QRS Detector Disable

When the QRS signal exceeds + or -7 volts and pin 7 of U306B goes HI, C389 charges, CR389 turns on, and CR391 turns off. This allows the +7 volts through R391 to turn on Q392, and pulls CR352 and CR353 below +1 V, thus disabling the QRS Detector. A HI signal from CR257 and CR258, due to a lead fault or to the ECG channel being off, also causes Q392 to turn on and disable the QRS Detector. A HI pulse from the Pacer Detector momentarily turns on Q392 to disable the QRS Detector during a pacer signal.

Pacer Detector

This circuit keeps pacer signals from entering the Automatic Gain Control and the QRS Timer circuits. U181A is a differentiator with limited upper bandwidth. A pacer pulse at the input to C378 produces an output at pin 1 of U181A. When the pulse at pin 1 exceeds + or -5 volts, a negative output at the collector of Q381 triggers Q384 into conduction. This action discharges C387 in the positive direction, which causes Q392 to saturate and pull the cathodes of CR352 and CR353 below the +1 volt. This clamps the Q341 and Q360 emitters below +1 volt to lock out signals to the Automatic Gain Control and QRS Timer circuits for the duration of the Pacer Detector output pulse (about 50 milliseconds).

RESPIRATION BOARD

RESPIRATION BOARD CIRCUIT FUNCTIONS

The Respiration circuit (Fig. 3-3) accomplishes the following:

1. Provides a 50 kHz signal to ECG patient cable leads LA and RA to measure patient chest impedance. The circuit has the same isolation and protection characteristics as the ECG input circuit.
2. Amplifies the detected respiration signal.
3. Indicates when a fault exists in the input cables, wires, electrodes, etc.
4. Provides an amplified respiration display signal (amplitude variable with RESPIRATION SIZE control). Display baseline is positioned approximately at screen center, 2 centimeters above, or 2 centimeters below, depending upon status of other channels. See Table 3-1.
5. Provides a logic signal to the Conditioner board to indicate whether respiration channel is off or on. This signal is used to blank the digital readout of respiration rate when the respiration channel is turned off.
6. Provides a logic signal to the Pressure/Pulse board to allow display of the respiration channel. This logic signal also sets the baseline of the pulse display.
7. Provides an inspiration trigger to the Conditioner board for digital display of respiration rate and for analysis of respiration-rate-alarm conditions.

RESPIRATION AMPLIFIER CIRCUIT OPERATION

Respiration signal is produced from the change in patient chest impedance that is measured across the LA and RA leads of the ECG patient cable.

A 50 kHz Oscillator signal is sent to the patient through T422, T162 on the ECG board, and patient cable leads.

The chest impedance change (about $\Delta 1 \Omega$) is reflected back into T422 and detected by the Synchronous Detector to produce a respiration signal at TP441.

The respiration signal is amplified to produce the respiration wave used for the crt display. The respiration signal is also processed by the Inspiration Detector to produce the respiration trigger.

Logic signals indicating the status of the ECG and Pressure/Pulse channels select the appropriate respiration baseline position through the Respiration Trace Positioning Multiplexer.

50 kHz Oscillator

The oscillator consists of Operational Transconductance Amplifier, U408, and parallel resonant circuit L409 and C409. Positive feedback is provided from pin 6 to pin 3 of U408. The output of the oscillator at pin 6 of U408 is a 5 volt peak-to-peak sinewave.

U412 is a 2X non-inverting amplifier. The output of U412 at TP415 is a 10 volt peak-to-peak sinewave. The sinewave at TP415 is half-wave rectified and filtered by CR411 and C407 and fed back to bias input of U408 to keep the oscillator output amplitude constant.

Q406 turns the oscillator off and on depending on the position of RESPIRATION switch S470. When the respiration channel is on, S470 is open and the base of Q406 is at about -7 V. This keeps Q406 off and the oscillator running. When the channel is off S470 is closed +7 V is applied to R406 turning on Q406, and the oscillator is turned off.

Synchronous Detector

The 10 V peak-to-peak sinewave at TP415 appears across R423 causing a 2 mA peak-to-peak sinewave to appear in the primaries of T422 and T162.

C162 and L162 make up a series resonant trap at 50 kHz, effectively causing T162 secondary windings to be in series. T162 turns ratio between primary and secondary is 10:1. Thus, a 200 μ A, peak-to-peak (70 μ A rms), 50 kHz sinewave is present at patient cable leads LA and RA.

Static chest impedance can vary from 0 to 1500 ohms. Since there is a 1 k Ω resistor in each of the patient cable leads, the impedance seen in the secondary of T162 will be between 2 k Ω and 3.5 k Ω . The chest impedance is reflected through T162 secondary to the T422 secondary at pins 1 and 3. This results in a 400 mV to 700 mV (550 mV mean), 50-kHz signal at pin 2 of Synchronous Detector U430.

When the static chest impedance is at the mean value of 750 Ω , the 50-kHz sinewave at pin 2 of U430 is 550 mV. The Null adjustment, R425, is set so that the same amplitude sinewave appears at pin 10 of U430. This causes the output at TP441 to be at 0 V dc. With static chest impedances other than 750 Ω , the dc level at TP441 will be shifted plus or minus accordingly.

During inspiration (expansion of chest cavity), the static chest impedance changes about 1 Ω . This impedance change is reflected back to T422 to produce a 200 μ V change in the amplitude of the 50-kHz sinewave at pin 2 of U430. The 200 μ V change at pin 2 becomes the respiration signal at TP441.

The Synchronous Detector is driven by a 50-kHz squarewave at pins 1 and 11. The squarewave is produced by limiting the 10 V peak-to-peak sinewave from the 50 kHz Oscillator to ± 0.6 V with R427, CR427, and CR428. When the squarewave is at +0.6 V, transistors at pins 1 and 11 are on; when the squarewave goes to -0.6 V, transistors at pins 4 and 8 are on. The output from U430 drives operational amplifier U439B. Components C439, R441, and C441 filter out the 50 kHz ripple, leaving a dc voltage level.

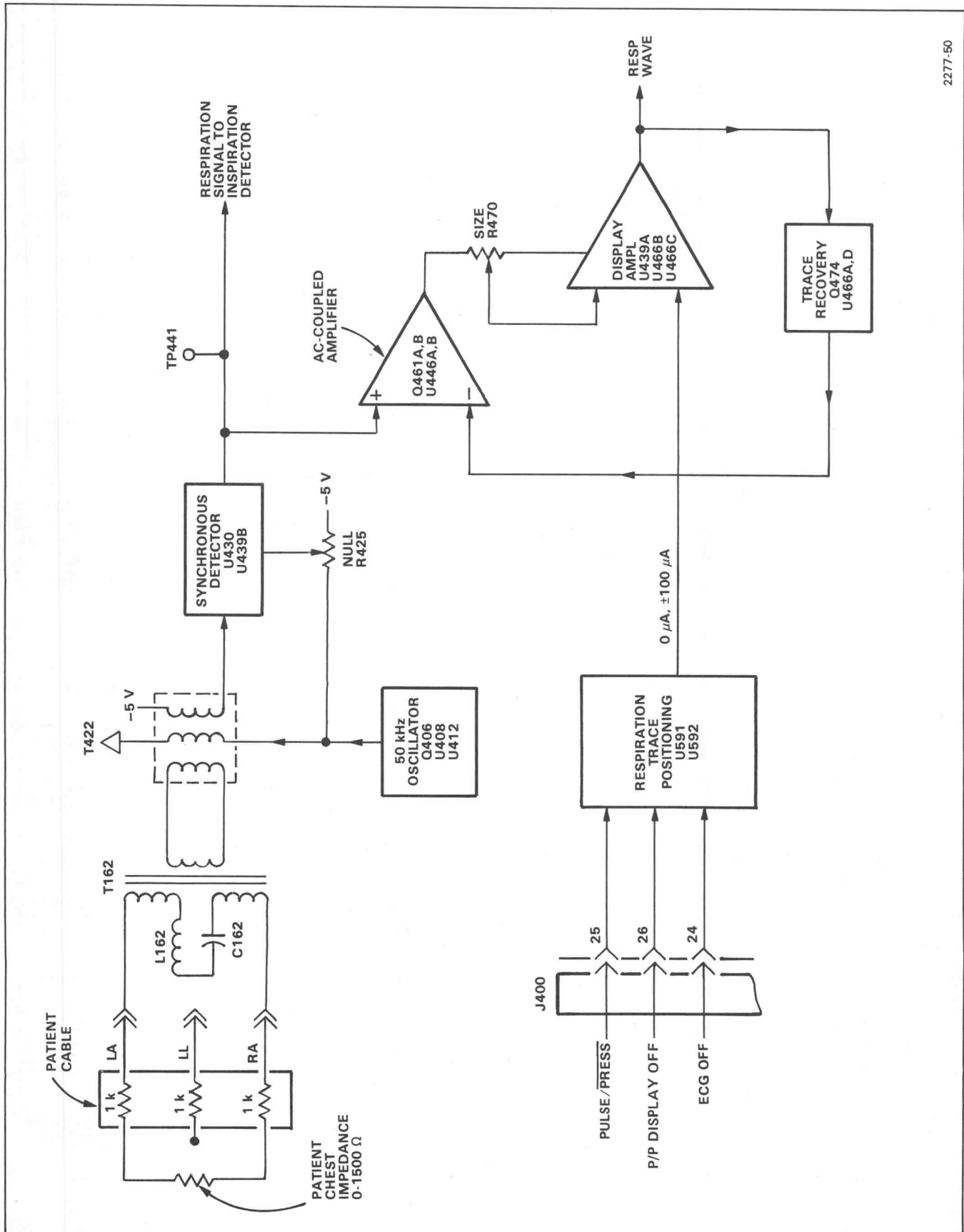


Figure 3-3. Respiration amplifier block diagram.

Ac-Coupled Amplifier

U446 and associated circuitry make up a special form of non-inverting amplifier with upper and lower bandwidth limits similar to that in the ECG channel.

Short duration overdrive signals will not shift the display baseline significantly because ac-coupling capacitor C461 is in the feedback circuit. The matched field-effect transistors Q461A and Q461B are connected as a source follower, and raise the load impedance to the ac-coupling network R473-C461.

The X200 amplifier gain is determined by R449, R446, R447, R450 and R452. High-frequency bandwidth (4 Hz) is determined by R446, R447, and C449. Low-frequency bandwidth (0.1 Hz) is determined by C461 and R473.

Display Amplifiers

The 1 V/ Ω respiration signal from pin 1 of U446A goes to inverting operational amplifier U466C. The gain of this amplifier is determined by R468, R469, and R470. The gain is variable with the SIZE control (R470) from X1/3 to X3. Gain of X1 is at R470 mechanical center, as marked by the dot on the front panel.

U439A is a X1 inverting operational amplifier which provides the respiration signal to the RESPIRATION OUTPUT jack.

U466B is an inverting operational amplifier with a gain of 1/2. Its output provides the respiration wave that goes to the vertical amplifier for the crt screen display. The Respiration Trace Positioning circuit sets the dc level of the respiration signal according to the status of the pressure/pulse and ECG channels.

Trace Recovery

The Trace Recovery circuit speeds up the return of an off-screen signal. When the dc level at pin 7 of U466B exceeds ± 1.0 V (corresponding to ± 4 centimeters on the screen), Q474 conducts, shunting R474 across R473 to speed the charging of C461 in the Ac-Coupled Amplifier.

Components U466A, CR482, and CR481 act as a full-wave rectifier so that Q474 turns on regardless of the polarity at pin 7 of U466B.

Capacitor C476 delays Q474 turn-on so that short-duration overdrive signals will not affect the Q474 and lead-fault circuits. C476 also delays Q474 turn-off to allow the recovery action to return the trace to its quiescent level.

Respiration Trace Positioning

U591 and U592 make up the Respiration Trace Positioning circuit. The output (pin 3) of U592 adds positioning current to the input of U466B at $+100 \mu\text{A}$, $-100 \mu\text{A}$, or $0 \mu\text{A}$ depending on the status of pressure/pulse and ECG channels. See Table 3-1 for trace positioning logic.

TABLE 3-1
Respiration Trace Positioning Logic

Channels Displayed In Addition To Resp	Trace Positioning Logic Signals			Positioning Level Output Pin 3, U592	Respiration Trace Position With Respect To Graticule Center		
	Pulse/Press J400-25	P/P Display Off J400-26	ECG Off J400-24		-2 cm	Center	+2 cm
NONE (Resp ONLY)	HI	HI	HI	0 μA (NC)		X	
Press ECG	LO	LO	LO	+100 μA	X		
NONE (Resp ONLY)	LO	HI	HI	0 μA (NC)		X	
Pulse ECG	HI	LO	LO	0 μA (NC)		X	
Pulse	HI	LO	HI	-100 μA			X
ECG	LO	HI	LO	+100 μA	X		
ECG	HI	HI	LO	+100 μA	X		
Press	LO	LO	HI	-100 μA			X

INSPIRATION DETECTOR CIRCUIT OPERATION

The Inspiration Detector circuit (Fig. 3-4) evaluates the content of the incoming respiration signal at TP441 to determine when inspiration (air drawn into lungs) occurs. The Inspiration Detector recognizes only positive-going slopes lasting at least 100 milliseconds.

When an inspiration signal has been detected, a respiration trigger pulse is generated that supplies respiration rate information to the rate and alarm circuits.

The respiration signal passes through the variable-Gain Amplifier, the Differentiator and the Absolute-Value-Detector. The resulting signal at TP517 is a positive-going pulse representing only the rising portion of the respiration signal. Feedback through the Automatic-Gain Control circuit maintains pulse amplitude at about 3 to 4 volts.

The portion of the pulse at TP517 over 1 volt passes through the Inspiration Level Detector to the Inspiration Timer. Only a pulse greater than about 100 milliseconds duration produces a respiration trigger. Pulses of shorter duration are ignored.

The Inspiration Detector is disabled when a lead fault occurs or when the RESPIRATION SIZE control is turned fully counterclockwise to the OFF position.

Variable-Gain Amplifier

U506B is a non-inverting operational amplifier. Variable-gain feedback to U506B is provided through the operational transconductance amplifier U523. The gain of U523 varies in direct proportion to the current at pin 5. The Automatic-Gain Control circuit varies the current at pin 5 of U523 from

3 to 300 μ A. A current of 300 μ A into pin 5 sets the gain of U523 to 100, and the over-all gain of the Variable-Gain Amplifier to 1. A current of 3 μ A into pin 5 sets the gain of U523 to 1, and the over-all gain to 100.

The components R521, C521, C522 provide low-frequency rolloff of about 0.1 Hz.

Differentiator and Absolute Value Detector

Respiration signal from the Variable-Gain Amplifier at TP506 are differentiated and inverted through U506A. The differentiated signal is then again inverted through U506D and half-wave rectified through CR516. The resultant signal at TP517 is one positive pulse for each rising portion of the respiration signal.

Inspiration Level Detector

The base of Q560 is set at +1 volt so that pulses at TP517, which are +1 volt or greater, pass through CR554 to the Inspiration Timer. Q541 base is set at +3 volts so that pulses at TP517, which are +3 volts or greater, pass through CR551 and turn on the Automatic-Gain Control circuit.

Inspiration Timer

When the Inspiration Level Detector detects a pulse over +1 volt from TP517, Q560 turns on causing Q567 to turn off. (Prior to this Q567 was saturated and C567 was discharged.) When Q567 is turned off, C567 starts charging towards -7 volts. After about 100 milliseconds, pin 2 of U571 reaches the lowest threshold point (about -2.3 V), causing pin 3 to go HI to produce the leading edge of the respiration trigger. At the time Q560 turns on, which discharges C571 and holds U571 pin 3 HI.

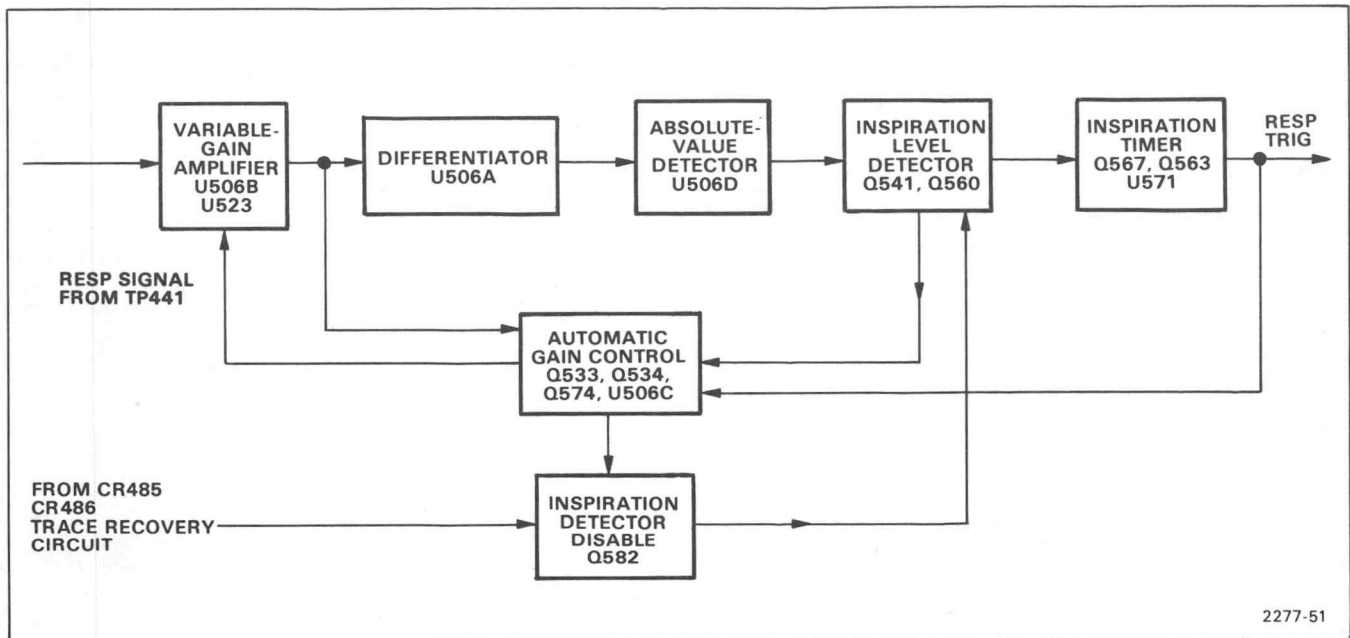


Figure 3-4. Inspiration detector block diagram.

Theory of Operation—413

When the respiration pulse at TP517 drops below +1 volt, Q563 is turned off, allowing C571 to charge toward +7 volts. When pin 6 of U571 reaches the upper threshold point (+2.3 V), pin 3 goes LO. The respiration trigger pulse at TP571 has a duration of about 150 milliseconds longer than the respiration pulse at TP517.

Automatic-Gain Control

When a pulse at TP517 is +3 volts or greater, Q541-Q533-Q534 turn on, and the current into pin 5 of U523 is increased. The increase in current into U523 increases the negative feedback in U506B and decreases the overall gain.

If a respiration signal is not present for several seconds, pin 3 of U571 remains LO and cuts off Q574 long enough for C574 to charge and turn on CR543. This quickly reduces the current in Q533 and Q534, and increases the gain of the Variable-Gain Amplifier to maximum. When the respiration signal returns, VR549 conducts through R549 to rapidly reduce the gain to normal.

When the respiration signal at TP506 exceeds + or -7 volts, pin 8 of U506C goes HI, turning on Q534 harder, thus decreasing the gain of the Variable-Gain Amplifier.

Inspiration Detector Disable

When the respiration signal exceeds + or -7 volts and pin 8 of U506C goes HI, C579 charges, CR579 turns on and CR581 turns off. This allows the +7 volts through R581 to turn on Q582 and pull CR552 and CR553 below +1 volts, thus disabling the Inspiration Detector. A HI signal from CR485 or CR486, due to a lead fault or to the respiration channel being turned off (S470 closed), also causes Q582 to turn on and disable the Inspiration Detector.

PRESSURE/PULSE BOARD

PRESSURE/PULSE BOARD CIRCUIT FUNCTIONS

The Pressure/Pulse Circuit (Fig. 3-5) accomplishes the following:

1. Provides excitation power to the pressure transducer and pulse sensor.
2. Amplifies the pressure transducer and pulse sensor output signals. In the pressure channel, three amplification ranges are provided:

0-125 mmHg, 25-75 mmHg, and 0-25 mmHg. In the pulse mode, the relative amplitude of the display is variable with the SIZE control.
3. Provides zeroing for pressure transducer imbalance. ZERO control is accessible at front panel.

4. Provides 100 mmHg calibration check of pressure channel which can be activated by 100 mmHg CHECK pushbutton on front panel (100 mmHg display on 0-125 range and overrange on the other ranges).

5. Provides an amplifier pressure or pulse output signal to a rear panel jack. In pulse mode, output amplitude varies with SIZE control setting.

6. Provides a scaled pressure signal to the Conditioner board for derivation of systolic, diastolic and mean values.

7. Provides an amplified pressure or pulse display signal to the vertical amplifier. In the pressure mode, the display zero is offset three centimeters below screen center (except in the 25-75 mmHg range, which is offset 2.5 centimeters below the bottom graticule line). In the pulse mode, the display baseline is positioned to the center of the screen when the ECG and respiration channels are off (single trace) or two centimeters below screen center when either or both ECG and respiration channels are on.

8. Provide a logic signal to indicate whether the pressure/pulse channels are on or off. This signal goes to the respiration board for respiration display baseline positioning.

9. Provides a logic signal to the Conditioner board to blank digital readout of systolic/diastolic and mean pressure when pulse is selected.

10. Provides a logic signal to the Conditioner board to blank the digital readout of pressure values when no pressure transducer is connected to the PRESSURE TRANSDUCER INPUT connector.

11. Provides a logic trigger signal that switches from LO to HI during the positive-going portion of a pressure or pulse waveform. This signal is sent to the Main board to be selected for sweep triggering, heart-rate alarm, beat tone, and heart-rate digital display when the ECG channel is not on. It also goes to the Conditioner board to be used for pulse alarm in pulse mode only.

12. Provides a logic signal to the ECG board to set the ECG display baseline. When both pressure/pulse and respiration channels are off, the ECG baseline is set to the center of the screen. When either or both pressure/pulse and respiration are on, the ECG baseline is set two centimeters above screen center.

PULSE AMPLIFIER CIRCUIT OPERATION

The pulse circuit consists of a Pulse-Sensor Excitation Supply and an ac-coupled Pulse Amplifier to amplify the pulse sensor output signal. The pulse sensor consists of a light (incandescent or LED) and a photo resistor. Pulse signal is produced when the photo resistance changes with varying light intensity due to peripheral blood volume changes.

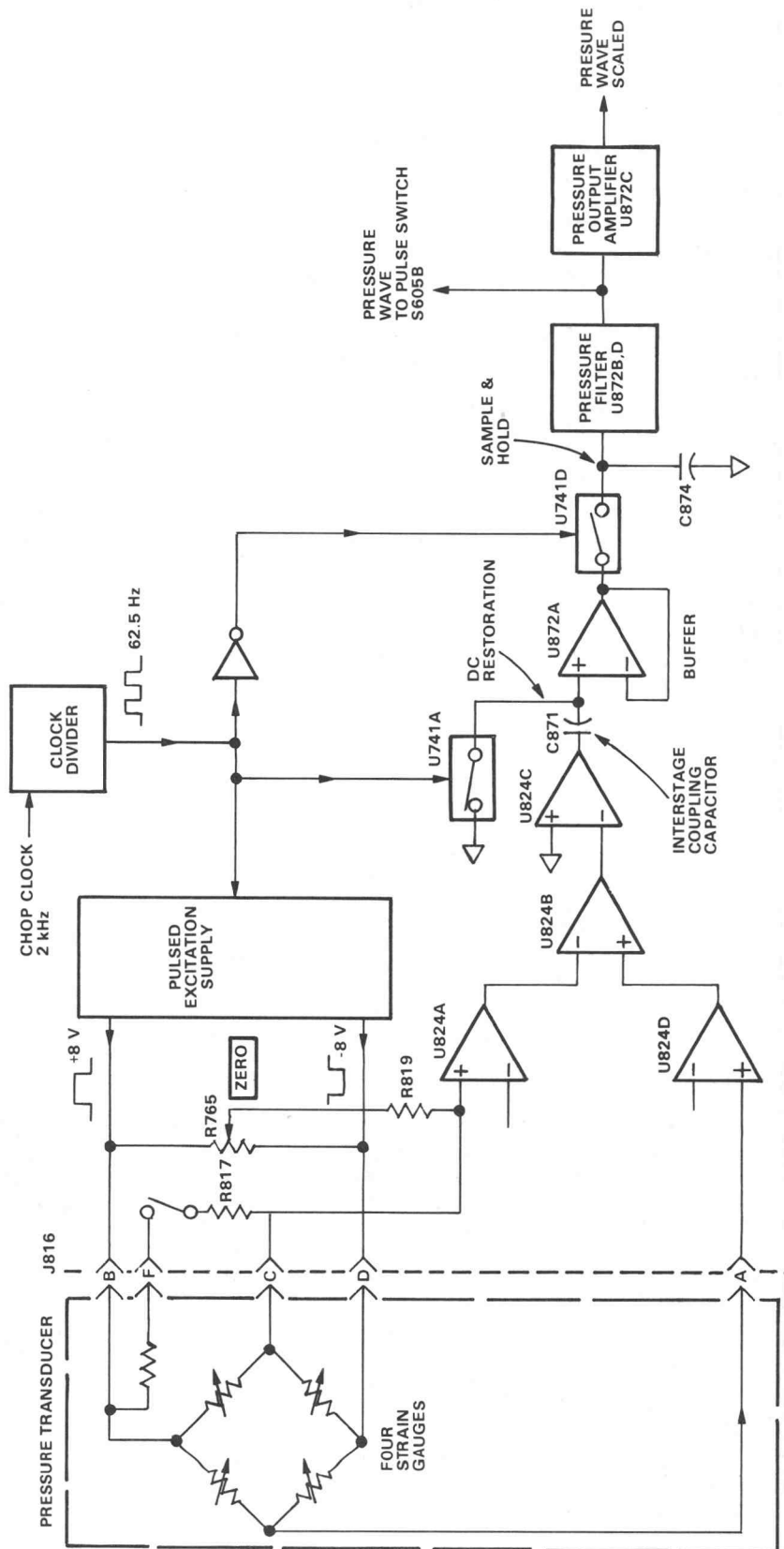


Figure 3-5. Pressure amplifier block diagram.

The pulse signal is amplified by the Pulse Amplifier. A Trace Recovery circuit is provided to quickly return large, off-screen signals.

Pulse-Sensor Excitation Supply

This supply is zener referenced to provide a constant output voltage. U639B is an inverting operational amplifier with a closed loop gain of less than one with respect to the voltage reference. R671 and R667 determine the gain reduction needed to reduce the -8.2 V at zener diode VR670 to +3.6 V at the emitter of Q666.

Pulse Amplifier

The Pulse Amplifier consists of three stages (U615, U619D, and U619A), which remove the dc component from the pulse signal, and an inverting operational amplifier U639A for pulse signal output. U619A output is centered around ground. U615 is an integrator which nulls any dc offset. Ac feedback is provided through R623 and C616 causing the low-frequency rolloff to be about 0.1 Hz. High-frequency rolloff is determined by C618 and C621.

The pulse signal at pin 1 of U619A is developed across the pulse SIZE control and passes through inverting operational amplifier U639A. The maximum total gain of the Pulse Amplifier circuit, from input at pin 1 of U619D to the output at pin 1 of U639A, is about 900. The gain is variable by the SIZE control to a minimum of about 45.

Pulse Trace Recovery

U619B, U619C, and associated circuitry provide for rapid return of off screen pulse signals.

Pin 10 of U619C is set at -2.5 V and pin 5 of U619B is set at +2.5 V. When the pulse signal at pin 1 of U639A exceeds -2.5 V, pin 8 of U619C goes HI turning on CR626 and CR628. This places R624 in parallel with R623, thus raising the lower rolloff frequency. Similarly, when the pulse signal at pin 1 of U639A exceeds +2.5 V, pin 7 of U619B goes LO and turns on CR627 and CR629.

PRESSURE AMPLIFIER CIRCUIT OPERATION

The Pressure Amplifier circuit (Fig. 3-5) is chopper stabilized. The excitation voltage supplied to the pressure transducer is pulsed to provide part of the chopping signal to the amplifier. When the Pressure-Transducer Excitation Supply is off, the inputs to the high-gain amplifier (U824A and U824D) are effectively shorted together through the transducer resistance, creating a no-signal condition. When the excitation supply is turned on, a pulse whose amplitude is proportional to pressure appears at the output of the interstage coupling capacitor.

During the time that the excitation supply is turned off (controlled by 62.5-Hz clock pulse), the interstage coupling capacitor (C871) is grounded through U741A. Thus any input amplifier offset, including drift, establishes a charge on C871. At this time, U741D is open.

Shortly before the excitation supply is turned on, U741A opens, removing the ground from C871. Now when the excitation supply turns on, the pressure pulse appears at

U824C output. Since C871 was previously charged to the amplifier offset level, only the signal representing the pressure level is passed on (dc restoration).

The sample and hold switch (U741D) now closes, the holding capacitor (C874) charges to the new signal level. U741D then opens, the excitation supply shuts off, and finally U741A closes and again grounds C871.

All amplification in the pressure channel precedes the interstage coupling capacitor. All subsequent stages are at unity gain. This method of amplification results in fewer operator controls. Since all dc offsets of the amplifier, including drift, are eliminated by this method, there is no need for a dc balance control. The only control required is ZERO, which corrects for residual imbalances in the pressure transducer and any unwanted pressure head due to elevation difference between patient and transducer.

Pressure-Transducer Excitation Supply

This excitation supply consists basically of a pair of inverting operational amplifiers Q787/U770A and Q767/U770B. The supply provides a pulsed + and -8 volts (16 V peak-to-peak) output to power the pressure transducer bridge.

When the 62.5-Hz clock pulse (from pin 11 of U737D) causes pin 8 of U711D to go HI, CR772 is turned on and pin 6 of U770B starts HI. Pin 7 starts LO and turns on CR769, reducing the gain to 1. Since pin 5 of U770B is at ground, pin 7 is one junction below ground, Q767 is turned off, CR767 is turned on, and the emitter of Q767 is held at zero volts.

When pin 8 of U711D goes LO, CR772 is turned off, causing pin 6 of U770B to start LO. Pin 7 of U770B starts HI: turning off CR769 and CR767 and turning on Q767. The gain of operational amplifier U770B is then set by R769 and R772/R773. This sets the emitter of Q767 at +8 V.

The pulsed +8 volt output at the emitter of Q767 is the input to inverting operational amplifier Q787 and U770A which produces the pulsed -8 volt output of the excitation supply. When the 62.5-Hz clock pulse at pin 10 of U737C is HI, diodes CR792/CR787/CR789 are turned off and the gain of U770A is one (determined by R768 and R789). Thus the emitter of Q787 is set to -8 volts.

When the clock pulse at pin 10 of U737C is LO, diodes CR792/CR787/CR789 are turned on and the emitter of Q787 is set to zero volts.

Pressure Input Amplifier

The + and -8 volt output from the Pressure Transducer Excitation Supply is applied to the pressure transducer bridge. The output of the transducer bridge is applied differentially to U824A and U824D. U824A and U824D are non-inverting operational amplifiers with an ac gain of about 11.

Capacitor C827 adds substantial degeneration to the amplifier to keep the quiescent dc level low at the output of U824B. Since the amplifier is chopper stabilized, flat response to dc is not required.

The outputs of U824A and U824D are applied to differential-to-single-ended-out amplifier U824B. The output of U824B is applied to inverting operational amplifier U824C. Pressure display ranges are selected by changing U824C input resistance values. The Gage Factor adjustment (R865) varies the gain by changing U824C feedback resistance.

The ZERO control R765 provides a + or - offset current to the Transducer bridge to correct for residual imbalance.

The 100 mmHg CHECK pushbutton connects the 8 volt side of the excitation supply through a calibration resistor (in transducer) to the U824A input, simulating a 100 mmHg pressure level.

If no transducer is connected to the input, Q844 turns on and disables the pressure channel.

Clock Divider

The 2 kHz clock signal from the Main board is divided down to 62.5 Hz through U736, U726A, U726B, and U726D. A 1-Hz clock signal, for the Pressure/Pulse-Respiration trace chopping, is taken off at pin 12 of U736.

Pressure Amplifier Chop Logic

Fig. 3-6 shows the time relationships between the Clock Divider output and transmission gates U741A and U741D. The chopping signal is applied to transmission gate U741A through delay network C796 and R796. CR796 permits only the closing of U741A to be delayed; the opening is not delayed. Similarly, CR797 causes C797 and R797 to delay only the closing of U741D.

Components C794 and R794 cause both turn-on and turn-off of the excitation supply to be delayed. When no transducer is connected to the PRESSURE TRANSDUCER INPUT connector, and R822 is connected to -7 volts, pins 12 and 14 of U824D go LO, turning off CR842 and turning on Q844. The LO at the collector of Q844 holds pin 10 of U739C and pin 11 of U739D HI and pin 10 of U737C LO. This keeps the Pressure Transducer Excitation Supply off. U741A and U741D close, thus disabling the pressure channel.

Pressure Filter

Components R876, R877, C876, C877, C878 and U872D make up a 2-pole, low-pass, Butterworth filter. Primarily, this filter smooths the reconstruction of the pressure signal which is delivered by the sample and hold circuitry.

Pressure wave output from this filter goes to the Press/Pulse selector switch where either pressure or pulse display is selected for the crt display.

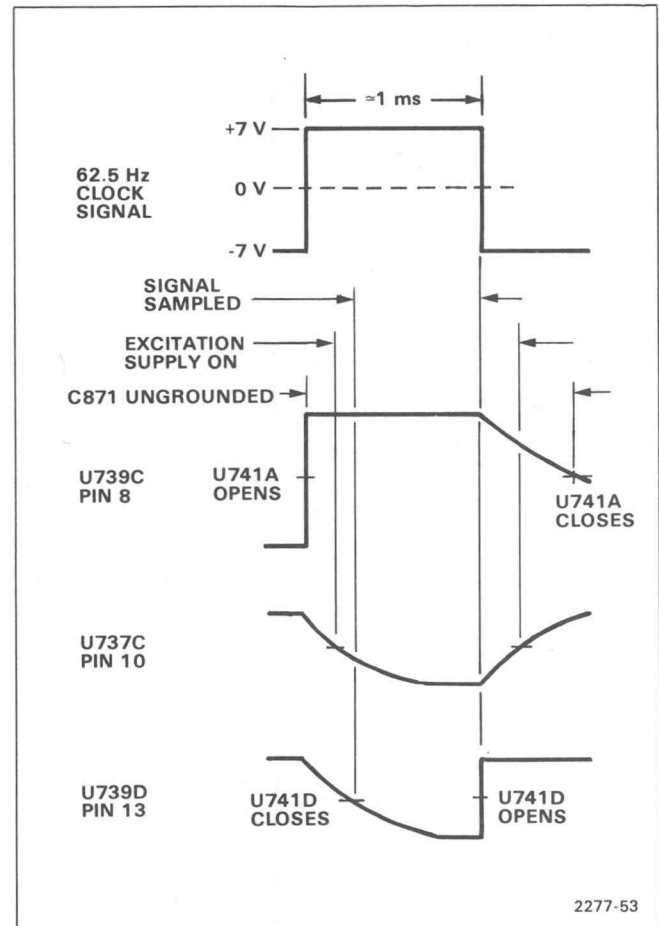


Figure 3-6. Clock-divider output and transmission-gate time relationships.

Pressure Output Amplifier

This circuit attenuates the pressure wave from the Pressure Filter circuit by the same ratio as the signal is amplified in the Pressure Input Amplifier. The output is a constant 10 mV/mmHg, regardless of gain (range) setting. The scaled pressure wave is used to produce pressure values for the digital display.

Pressure/Pulse-Respiration Trace Chopping

Switches U741B and U741C close to connect the respiration and/or pressure/pulse waves to the Pressure/Pulse/Respiration Display Amplifier. When both channels are displayed simultaneously, U741B and U741C are opened and closed alternately by the 1-kHz clock from the Clock Divider. Figure 3-7 shows the switching logic for this circuit.

When both pressure/pulse and respiration channels are off, a HI signal from pin 12 of U711F is sent to the ECG board to position the ECG display to the center of the screen.

When either or both pressure/pulse or respiration channel is on, this signal is LO and the ECG display is positioned two centimeters above the center of the screen.

When both pressure/pulse and respiration channels are on, pin 5 of U737B is LO and 2-kHz chop blank pulses are produced at pin 4 of U737B.

Pressure/Pulse Trigger Detector

This circuit converts the pressure or pulse signal, out of the Pressure Filter circuit, to a step signal at U702B output. The step at U702B output is inverted by U711B.

The inverted step triggers the horizontal sweep, rate alarm, beat tone, and heart rate digital display when the ECG channel is off.

The trigger circuit produces positive-going step of approximately -7 to +7 volts at the inverter output, at about 150 millivolts above the most negative excursion of the pressure or pulse signal. See Figure 3-8.

As the input signal goes negative, pin 3 of U702A is more negative than pin 2. Pin 1 goes negative, CR702 conducts, and the charge on C702 goes negative with the input on pin 3.

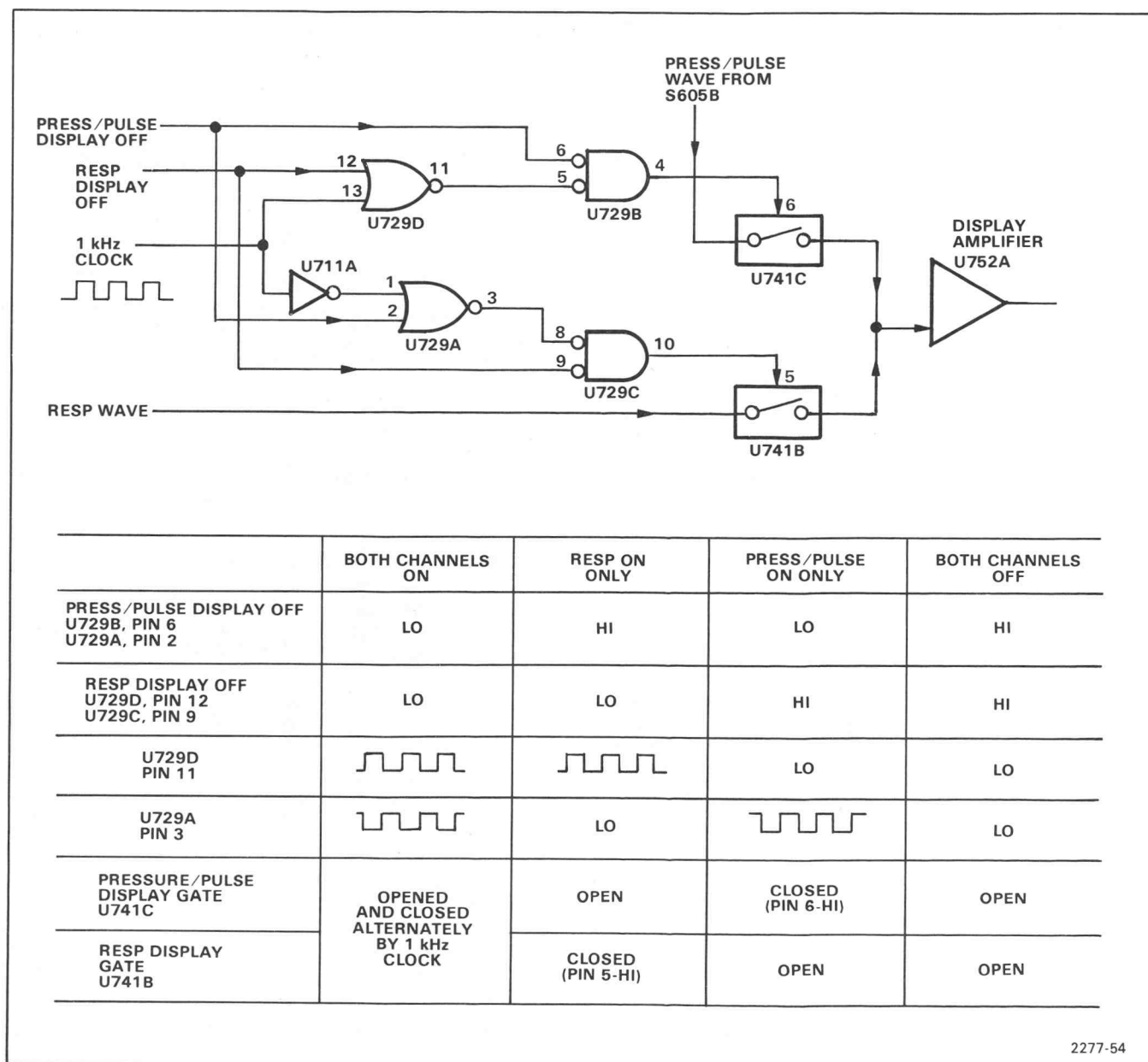


Figure 3-7. Pressure/pulse-respiration trace-chopping logic.

The input signal reaches its most negative excursion and starts positive. Since pin 2 is held at the most negative excursion of the input signal and pin 3 starts positive, pin 1 goes positive and turns off CR702.

Pin 6 of U702B is approximately 100 millivolts below the input signal due to current in R703 (set by R704 to -7 V).

Pin 7 of U702B is HI (approximately +5 V). The approximately 5 microamperes of R707 current through R706 sets pin 5 at about 50 millivolts above the voltage on C702.

When the input signal rises to about 150 millivolts (100 millivolts plus 50 millivolts) above its most negative excursion, U702B switches, pin 1 goes LO, and pin 4 of U711B goes HI. Since pin 7 of U702B has now dropped to about -5 volts, pin 5 goes to about 50 millivolts below the voltage on C702.

As the input signal continues to rise, C702 charges slowly in the positive direction, as shown in Figure 3-8. The input signal reaches its most positive excursion and starts back down. Nothing further occurs until the level at pin 6 of U702B drops more negative than pin 5 (i.e., when the input signal drops below a level 50 millivolts above the voltage on C702).

Now, U702B switches back, pin 7 of U702B goes HI, and pin 4 of U711B goes LO. Thus, the trigger signal is a step related to the input signal as shown in Fig. 3-8.

Pressure/Pulse/Respiration Display Amplifier

U752A and U752B provide the appropriate signal levels for display of the pressure, pulse, or respiration waves.

Pressure/pulse and/or respiration waves are selected by U741B and/or U741C.

When respiration wave is selected by U741B, the gain of U752A is 1 (as determined by R752 and R723). Diodes CR727 and CR728 hold U752A input level to within 0.6 volts of ground.

When pressure or pulse is selected by U741C, the gain is determined by R752 and R686 (or by R752 and R686 in parallel with R696). If pulse, pressure 0-125, or pressure 0-25 is selected, the gain of U752A is 0.5, as determined by R752 and R696 in parallel with R686. In the pressure mode, R689, R688, and R690 (Trace Zero adjustment) are connected to the U752 input to appropriately set the pressure-trace zero position on the crt. For the 0-25 and 0-125 pressure positions, the trace zero is set to the bottom graticule line.

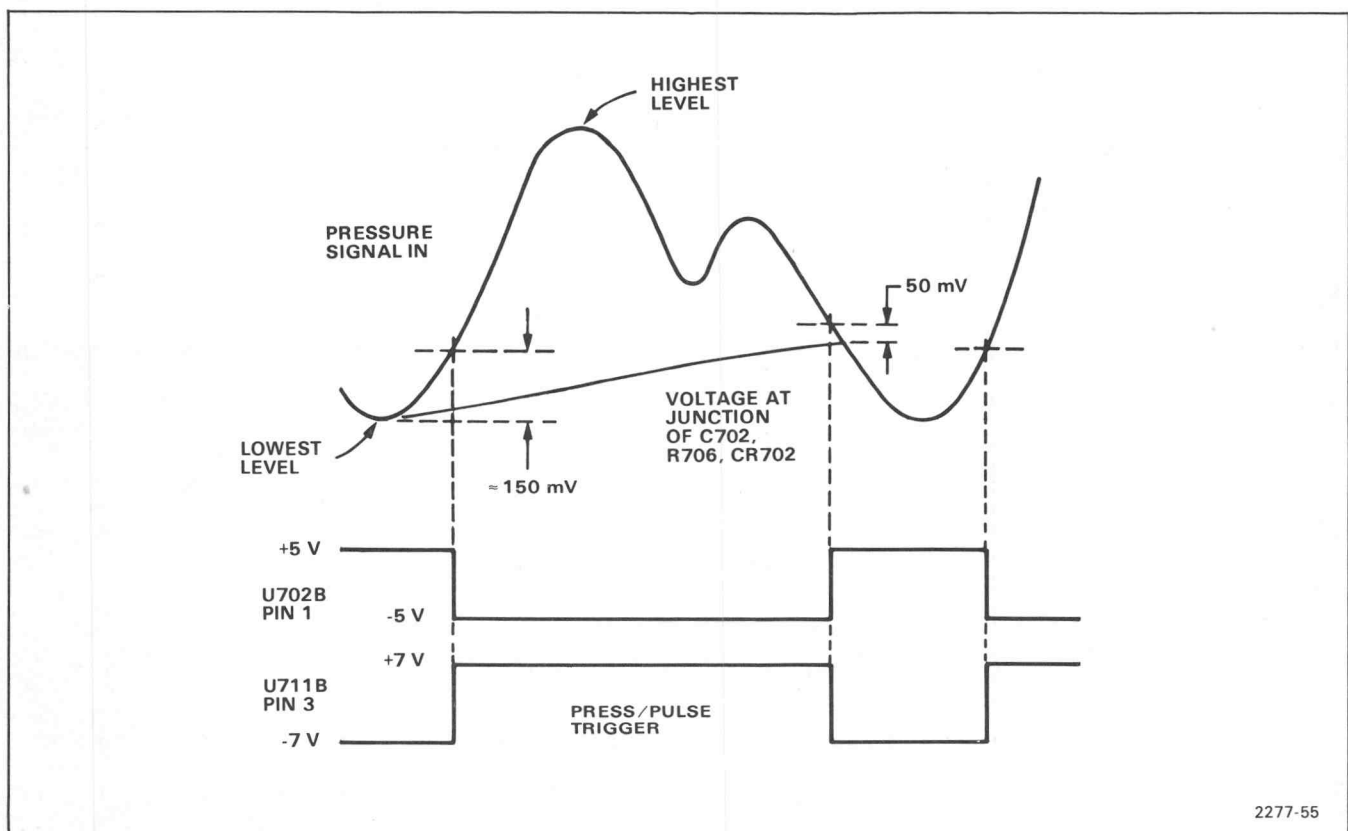


Figure 3-8. Pressure/pulse trigger points.

Diodes CR752, CR753, and CR754 reduce the gain of U752A when the output (pin 1) attempts to go above about +1.8 volts.

U752B is an inverting operational amplifier with a gain of 1. The output at pin 7 of U752B drives the vertical amplifier.

MAIN BOARD

MAIN BOARD CIRCUIT FUNCTIONS

The Main board circuits accomplish the following:

1. Select the signal(s) to be displayed on the crt, depending upon the status of the pressure/pulse-respiration and ECG channels.

The Trace Switching Logic circuit chops between the ECG and the pressure/pulse and/or respiration signals to provide a dual- or three-trace display.

ECG is displayed single-trace when both pressure/pulse and respiration channels are off. When the ECG channel is off, pressure/pulse and respiration channels are displayed single-trace or dual-trace as determined by circuitry on the Pressure/Pulse board. When all three channels are on at the same time, three traces are displayed.

2. Amplify the selected display signal to drive the vertical deflection coil.

3. Select trigger signal to be used. When the ECG channel is on, the ECG trigger signal is selected. When the ECG channel is off, the pressure/pulse trigger is selected. The selected trigger is used for digital display of heart rate, sweep triggering, beat tone, analysis for heart-rate alarms, and for RATE OUTPUT on the rear panel.

4. Provide for triggered sweep. A sweep generator signal is amplified by the horizontal amplifier to drive the horizontal deflection coil.

5. Provide audio tone for alarm sound or beat tone. The circuit is triggered by the selected trigger or gated on by an alarm signal from the Conditioner board.

6. Provide an ECG LEAD CHECK signal to check patient cable continuity and ECG amplifier operation.

7. Provide power and signal distribution between the circuit boards.

8. Provide battery or ac-line voltage to power the converter in the primary circuit. When the ac-line plug is connected to an ac outlet, the battery will be charging

and the monitor will operate from the ac line when the POWER button is pushed in. When the ac plug is not connected, the monitor will operate from battery power.

VERTICAL CIRCUIT OPERATION

The Vertical Deflection circuit amplifies ECG or pressure/pulse-respiration waves, selected by the Trace-Switching Logic circuit, and drives the vertical deflection coil.

ECG Off and Pressure/Pulse & Respiration Display Off Logic Signals determine whether channels are displayed alone or simultaneously. When both channels are selected, a 2-kHz clock signal drives electronic switches (U1632A and B) which chop between the two channels.

A 4-kHz crt blanking signal is produced during the channel-switching interval to eliminate switching transients from the display. The Vertical Boost circuit provides for rapid change of deflection-coil current during the channel-switching interval.

Clock Oscillator and Dividers

Transistors Q1613 and Q1617 make up an 8-kHz Oscillator. The frequency is adjustable with R1610. The negative-going excursion of the 8-kHz Oscillator output at the collector of Q1617 turns on Q1621, producing a positive-going pulse which clocks the divide-by-two counter, U1623A. The 4-kHz negative-going output at pin 2 is used for chop blanking and vertical boost.

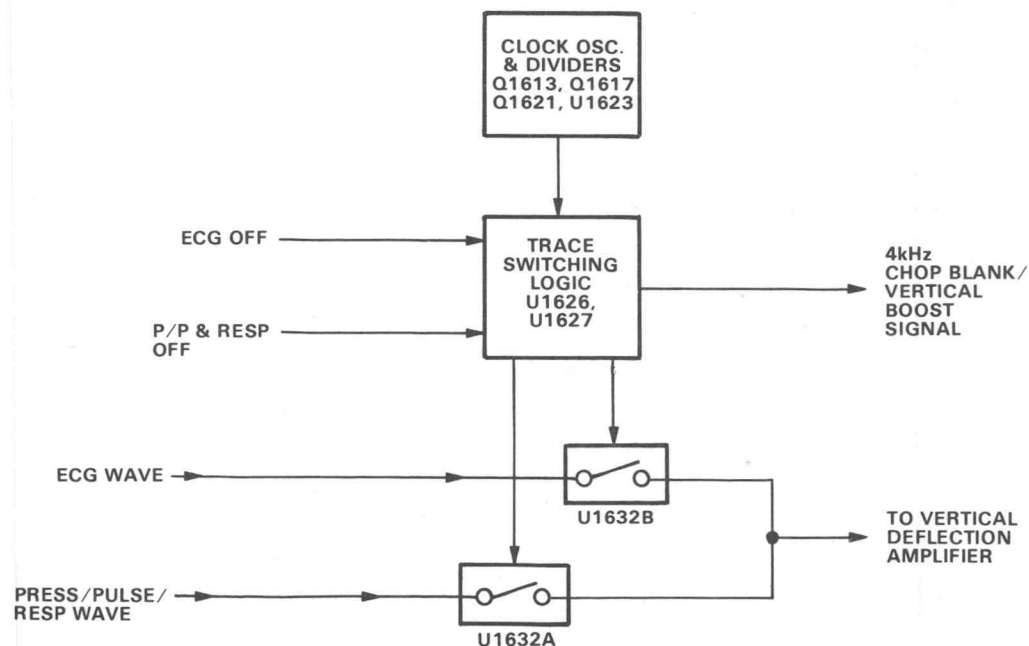
The positive-going output at pin 1 of U1623A clocks the divide-by-two counter U1623B. The 2-kHz positive-going output at pin 13 is used for trace switching, sweep triggering, sweep generation, and alarm tone. It also goes to the Pressure/Pulse board for pressure/pulse-respiration display switching. The negative-going output at pin 12 is used for trace switching along with the positive-going output at pin 13.

Trace-Switching Logic

Transmission gates U1632A and B close to connect the ECG or pressure/pulse/respiration waves to the Vertical Deflection Amplifier. A HI at pin 13 of U1632A connects the pressure/pulse/respiration wave to U1649. A HI at pin 5 of U1632B connects the ECG wave to U1649. When the pressure/pulse/respiration and ECG channels are on at the same time, U1632A and B are closed and opened alternately by the 2 kHz clock signal to display channels simultaneously. See Figure 3-9 for switching logic.

Channel Selection Logic

Pressure/Pulse and Respiration Off signal from the Pressure/Pulse board is inverted in U1702A, then inverted again in two parallel inverters U1702B and C. This is to provide additional fan-out current and to standardize logic level voltage. Similarly the ECG Off signal is inverted by U1702F and again by U1702E and D.



	ECG AND PRESS/PULSE/RESP DISPLAYS ON	ECG DISPLAY ON ONLY	PRESS/PULSE AND/OR RESP DISPLAYS ON ONLY	ALL DISPLAYS ON
ECG OFF SIGNAL	LO	LO	HI	HI
PRESS/PULSE & RESP OFF SIGNAL	LO	HI	LO	HI
U1626C PIN 10			LO	LO
U1627B PIN 4		HI	LO	LO
U1627D PIN 11		LO	HI	LO
U1626A PIN 3		LO		LO
ECG WAVE GATE U1632B	OPENED & CLOSED ALTERNATELY AT 2 kHz CLOCK RATE	CLOSED	OPEN	OPEN
PRESS/PULSE/RESP WAVE GATE U1632A		OPEN	CLOSED	OPEN
4 kHz CHOP BLANK/ VERTICAL BOOST U1626B PIN 4		LO	LO ¹	LO

¹ 4 kHz CHOP BLANKING & VERTICAL BOOST SIGNAL PRESENT WHEN PRESS/PULSE AND RESPIRATION CHANNELS DISPLAYED SIMULTANEOUSLY.

2277-56

Figure 3-9. Trace-switching logic.

Vertical Deflection Amplifier

Integrated circuit U1649 and its associated circuitry, is basically a voltage follower configuration of an operational amplifier as in Fig. 3-10A. Output current of this stage is determined by R1687, which loads the amplifier output as shown in Fig. 3-10B. The vertical deflection coil is then added in series with the amplifier output as in Fig. 3-10C. Thus, Fig. 3-10C is the basic circuit for the vertical amplifier.

Transistors Q1666, Q1667, Q1676, and Q1677 are current boosters for the operational amplifier output. Q1662 and Q1672 provide the interface between the output of U1649 and the boost transistors, and allow voltage swing up to ± 35 volts.

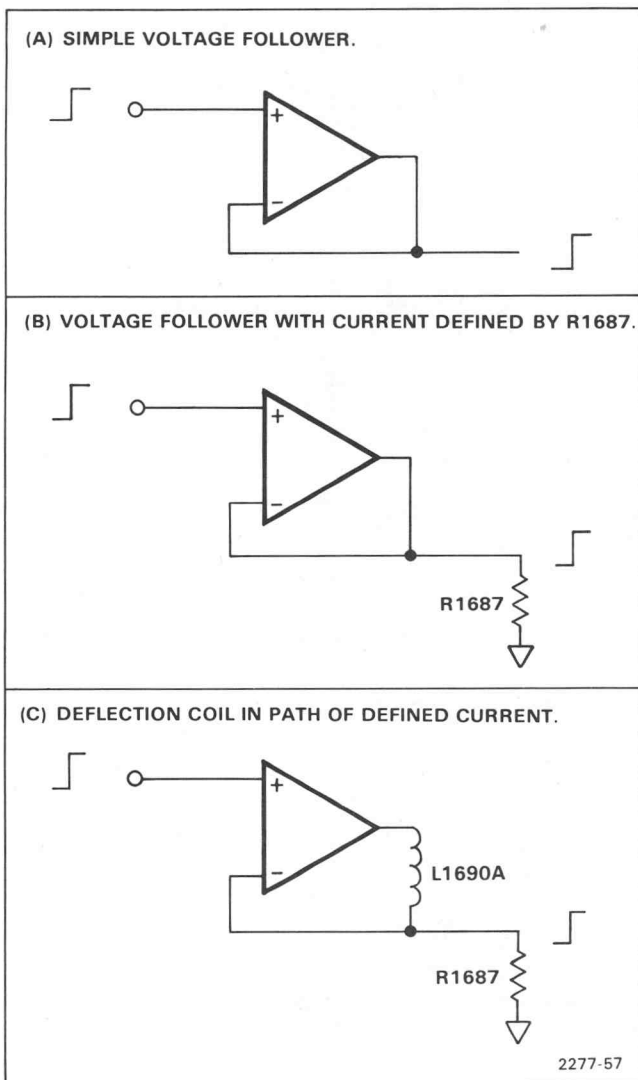


Figure 3-10. Vertical-deflection amplifier.

DS1648 and DS1649 are light-emitting diodes (used as voltage clamps) which limit the input voltage for U1649 to + or -1.5 volts. This prevents the amplifier from trying to establish unnecessarily high current levels in the vertical deflection coil.

Some rapid changes at the input of U1649, such as the chop transition from one trace to another, cannot be followed instantaneously by the output. This can create a substantial difference between the input and the feedback voltages. Therefore, the bi-directional clamp, Q1656 and Q1657, limits Q1662 and Q1672 collector current to a value that is usable by the output stage.

A 70-microsecond vertical boost pulse from U1633A causes Q1663, Q1664, Q1673, and Q1674 to switch the amplifier power supply from + and -7 volts to + and -35 volts. This higher voltage decreases the time required for the current to change in the vertical deflection coil.

The chop blank pulse, occurring at the same time that the trace is switched, triggers 20-microsecond one shot multivibrator U1633B. The vertical boost multivibrator, U1633A, can be triggered during the 20 microsecond LO at pin 1. If the amplifier begins to limit due to the chop transition, Q1656 and Q1657 are turned on. This turns on Q1642, causing pin 3 to go HI and release the reset. Pin 2 goes HI (after C1641 discharges) to trigger U1633A.

The resultant 70-microsecond (maximum) pulse at pin 13 of U1633A turns on Q1663, Q1664, Q1673, and Q1674 to increase the output amplifier collector voltage to + and -35 volts.

Capacitor C1641 prevents U1633A from resetting for the duration of the vertical boost. Transients, which momentarily turn off Q1642, cannot cause pin 3 to go LO until C1641 has charged through R1641 and R1642.

HORIZONTAL CIRCUIT OPERATION 8

The Horizontal circuit consists of a Trigger Selector, a Sweep Trigger Logic circuit, a Sweep Generator, and a Horizontal Deflection Amplifier to drive the horizontal deflection coil.

The Sweep Trigger Logic circuit produces an approximate 5 millisecond selected trigger signal. ECG or Pressure/Pulse Trigger signal is selected depending on the status of the ECG channel.

If the trigger pulses stop for about 4 seconds, the Sweep Trigger Logic circuit gates on the Sweep Generator to provide a free-running baseline trace.

The Sweep Generator produces a sawtooth signal that is amplified by the Horizontal Amplifier to drive the horizontal deflection coil.

Trigger Selector

Gates U1632C and U1632D select either the ECG or Pressure/Pulse Trigger signal. When the ECG channel is on, U1632C is closed (pin 6, HI) and U1632D is open (pin 12, LO) selecting the ECG Trigger signal. When the ECG channel is off U1632C is open (pin 6, LO) and U1632D is closed (pin 12, HI) selecting the Pressure/Pulse Trigger signal.

Sweep Trigger Logic

The selected trigger signal from U1632C or D triggers U1706B to produce a 5 millisecond selected trigger pulse.

When pin 9 of U1707A goes LO and the sweep retrace has ended, a sweep will start. If pin 9 is held LO, a new sweep will be started at the end of each retrace cycle. Pin 9 goes LO whenever any of the three inputs in 1, 2, or 8) go HI.

Pin 1 goes HI (through R1742 to +7 V) whenever P1742 is removed (for free run at all sweep speeds). Also pin 1 goes HI at selected sweep speeds when the appropriate resistor (R1781 through R1784) is removed (normally for 12.5 & 25 mm/sec).

Pin 2 goes HI for 5 milliseconds each time a selected trigger pulse is produced by U1706B.

Pin 8 goes HI to free run the sweep if no selected triggers occur for at least 4 seconds.

U1709 is a counter which is clocked by the 2-kHz clock signal and is reset each time a 5-millisecond selected trigger pulse occurs. If the selected trigger pulses stop, U1709 is not reset and counts for about 4 seconds until pin 3 goes HI and stops the clock pulses through U1707C. With no clock pulses, U1709 pin 3 is held HI until the selected trigger pulses resume, which resets U1709, causing pin 3 to return LO. As long as pin 3 of U1709 remains HI, pin 8 of U1707A is HI and the sweep is free-running.

A flip-flop (U1712A) widens the 5-millisecond selected trigger pulse to approximately 68 milliseconds for beat tone and for RATE OUTPUT at the rear panel.

Each time a 5-millisecond selected trigger pulse occurs, U1712A pin 2 is set LO and counter U1709 starts counting. After 128 counts, pin 13 goes HI and clocks U1712A, which causes pin 2 to go HI. Thus with each trigger pulse a 68-millisecond LO pulse is produced at pin 2 of U1712A. This turns off CR1717 and allows the 2-kHz clock signal to pass through CR1719 to the Audio Amplifier for 68 milliseconds.

The 68-millisecond trigger pulse at pin 2 of U1717A also passes through amplifier Q1713/Q1714. This produces a +5.5 volt, 68-millisecond pulse capable of providing about 12 milliamperes to the rear panel RATE OUTPUT jack.

Sweep Generator

The sawtooth sweep signal is produced by counter U1810 and R-2R resistive ladder network R1820. U1810 is clocked by the appropriate clock pulse as selected by the SWEEP SPEED mm/SEC switch.

As U1810 is clocked, its output counts in the normal binary fashion. Due to the design of the R-2R ladder, each additional count produces an increase in the current into the Horizontal Deflection Amplifier. Thus, a staircase current ramp is produced which drives the horizontal deflection coil to move the electron beam across the crt screen.

At the 512th count, pin 14 of U1810 goes HI (ground), turning off Q1812 and triggering one shot U1706A. U1706A produces a 20-millisecond pulse which blanks the crt, sets U1712B pin 13 HI, and inhibits gate U1707B (pin 4 & 5 goes HI) from passing further triggers. The HI at pin 13 of U1712B turns on Q1776, causing pin 11 of U1810 to go HI and reset the counter to zero.

At the end of the 20 millisecond pulse, pin 4 and 5 of U1707B goes LO. If pin 3 is also LO due to a trigger pulse or to being held LO for a free-running sweep, pin 6 of U1707B will go HI. This resets U1712B, causing pin 11 of U1810 to go LO and allowing another sweep to start.

Sweep speeds are determined by the rate at which U1810 is clocked. The 2-kHz clock signal at pin 10 of U1745 is counted down to 500 Hz, 250 Hz, 125 Hz, and 62.5 Hz at the Q2, Q3, Q4, and Q5 outputs respectively. The SWEEP SPEED mm/SEC switch selects the appropriate clock pulse from U1745 to clock U1810.

Horizontal Deflection Amplifier

U1841B and its follower transistors, Q1842 and Q1843, compose a conventional inverting type operational-amplifier circuit. The deflection coil is operated in the voltage mode so that the coil current is determined by the voltage across the coil divided by the coil resistance.

The amplifier impresses a negative-going sawtooth voltage at pin 2 of P1690 (deflection-coil plug). This voltage is fed through R1847, RT1690, and R1857 to the opposing half of the Horizontal Deflection Amplifier (U1841A, Q1852, and Q1853). The sawtooth is inverted through U1841A which impresses a positive-going sawtooth at the other side of the horizontal deflection coil.

Thermistor RT1690 compensates for changes in resistance of the horizontal deflection coil wire due to internal temperature changes.

AUDIO AMPLIFIER CIRCUIT OPERATION

The Audio Amplifier provides audible beat and alarm tones. Both tones are produced from the 2 kHz clock signal which is gated into the Audio Amplifier through CR1719 and CR1718, respectively.

The beat tone is produced when the trigger pulse from pin 2 of U1712A turns off CR1717 and allows the 2-kHz clock signal to pass through CR1719 for 68 milliseconds. This signal passes through the BEAT LOUDNESS control which sets the signal level into U1758.

The alarm tone is produced when the Audio logic signal goes LO (alarm detected), turns on CR1718, and allows the 2-kHz clock signal to pass to the ALARM LOUDNESS control to U1758.

ECG Lead Check

The ECG LEAD CHECK circuit provides approximate 117-beats-per-minute output pulses for checking patient cable continuity, ECG circuit operation, and high or low rate alarm limits.

The pulses are initiated by the Q7, Q8, Q9, and Q10 outputs of U1745. A negative-going pulse occurs at the RA lead check terminal (pin 1 of P1751) whenever all four outputs of the counter are LO. When the outputs go LO, diodes CR1746, CR1747, CR1748, and CR1749 turn off and CR1751 turns on, producing the ECG LEAD CHECK voltage across divider R1751/R1752/R1753 between -12 volts and ground. Outputs are as follows: RA to LL, 1.5 millivolts; RA to LA, 1 millivolt; LA to LL, 0.5 millivolts.

The duration of the pulse is determined by how long the Q7 output of the counter remains LO (about 32 milliseconds).

Capacitor C1751 gives the output pulses the appropriate rise and fall times to activate the QRS detector, but not the pace detector.

POWER SUPPLY CIRCUIT OPERATION

The Power Supply operates from either a 115 or 230 V ac power source or from the internal battery. When the ac-power plug is connected to an ac outlet, the battery charging circuit is activated.

The Battery Status circuit monitors the battery voltage to operate the dual LED BATTERY indicator and shut down the monitor when the voltage drops to approximately 4.6 volts.

The other supply voltages are regulated by means of a primary regulating circuit, referenced to the +5 V supply.

Ac-Line-Voltage Input

The ac-line voltage transformer, T1910, has two balanced primary windings. The windings are connected in parallel for 115 V ac operation and in series for 230 V ac operation. The transformer has two secondary windings. One supplies voltage through CR1910 to operate relay K1913 and the Battery Charger circuit. The other supplies power to the Power Supply Converter.

When the ac plug is connected to an ac outlet, K1913 closes to switch the power source from battery to ac and to turn on the Battery Charger circuit.

Battery Charger

The charging circuit consists of Q1939, Q1944, and Q1945. Charging current is supplied through R1943 and Q1945. The voltage developed across R1943 turns on Q1939, diverting current from the base of Q1944 which maintains the current through Q1945 at about 700 milliamperes. RT1922, U1926, and Q1936 make up a circuit which shuts down the charger when the battery temperature becomes excessive. Q1936 is normally turned off. RT1922 is mounted close to the battery pack. When internal temperature monitored by RT1922 gets high enough to cause the value of RT1922 to be about 20 K, pin 6 of U1926 goes HI, turning on Q1936. This turns on Q1939 harder, which turns off Q1944 and Q1945 and shuts off the charging current.

+2.5 V and +5 V Regulators

U1984 provides a highly stable +2.5 volt reference for the +5 volt supply, and for the DVM and temperature converter circuits.

A sample of the +5 V output is picked off at the center arm of the +5 V adjustment (R1990) and is compared against the +2.5 V reference voltage at the input to U1987C. If the +5 V output attempts to go up, pin 8 of U1987C goes down, increasing the current in Q1993 and holding the output at +5 volts. If the output attempts to go down, pin 8 of U1987C goes up, decreasing the current in Q1993, and holding the output at +5 volts.

Diode CR1987 allows U1987C output to operate well below its positive supply limit.

Divider R1996/R1997 sets the +4 V reference for the Battery Status circuit.

Power Supply Converter

Transistors Q1972, Q1973, and transformer T1972 make up an oscillator which produces a squarewave output to drive the various supply-voltage rectifiers. Squarewave frequency is in the range of 25-35 kHz and is dependent upon instrument load.

Converter Regulator

Transistor Q1967 controls the base drive to Q1972 and Q1973, thus regulating the converter output voltage. Error amplifier U1987D drives the base of Q1967 through Q2053.

A change in the -12 V supply causes a change at pin 14 of U1987D which, in turn, adjusts the converter drive through Q1967.

Converter Start-Up

Q1966 turns on momentarily during monitor turn-on to ensure converter startup. When the power switch is pushed in, a positive voltage is coupled through C1959, turning on Q1966. This, in turn, turns on Q1967 to provide maximum base drive to Q1972 and Q1973. When the -12 V

supply comes up, VR1961 clamps the base of Q1966 at -2 volts. This keeps Q1966 turned off, allowing U1987D to control Q1967. C1961 initiates the same start-up sequence when the line cord is plugged in with power applied.

Battery Status

The Battery Status circuit monitors the battery output voltage to control the BATTERY LED and the Low-Battery Shutdown circuit.

The BATTERY LED (DS2039) glows green at full intensity, when the battery voltage is 4.8 volts or more (or in process of being charged).

When the battery voltage drops to 4.7 volts, both the green and red LED sections glow at equal intensity (yellow). At this point there is 15-30 minutes of battery operating time remaining.

As the battery voltage drops below 4.6 volts, the LED glows red at full intensity. It is at this point that the Low-Battery Shutdown circuit is activated to shut down the monitor.

A summing node occurs at the junction of R2011 and R2012 such that when the battery voltage is 4.7 volts, pin 6 of U1987B is at 4 volts, the emitter of Q2021 is at 4 volts, and 10 milliamperes (20 mA required for full intensity) of current is flowing through Q2021 and the green side of DS2039. Also, pin 2 of U1987A is at 4 volts, the emitter of Q2029 is at 4 volts, and 5 milliamperes (10 mA required for full intensity) of current is flowing through Q2029 and the red side of DS2039. Thus, the green and red LEDs are on at one-half normal intensity.

When the battery voltage goes up to 4.8 volts, the emitter of Q2021 goes down one volt to +3 volts due to the X10 gain of inverting operational amplifier U1987B/Q2021. The emitter of Q2029 goes up one volt to +5 volts due to the X1 gain of inverting operational amplifier U1987A/Q2029. This causes 20 milliamperes of current to flow through R2014, Q2021 and the green side of DS2039, and no current to flow through Q2029 and the red side of DS2039. Divider R2018-R2019 limits the current to 20 mA when the battery voltage exceeds 4.8 volts.

When the battery voltage goes down to 4.6 volts, the emitter of Q2021 goes to +5 volts and the emitter of Q2029 goes to +3 volts. This turns off the green side of DS2039 and turns on the red side of DS2039 to maximum intensity (10 mA through R2026 and Q2029).

When pin 7 of U1987B goes positive and the green LED goes out, pin 6 of U2033 is switched HI, CR2041 and Q2051 are turned on, Q2053 and Q1967 are off, removing the base drive from the converter transistors Q1972 and Q1973. This shuts down the power supply.

During ac-power operation, the voltage output from CR1911, across divider R2046/R2047, keeps Q2049 turned on and Q2051 turned off, preventing converter shutdown.

CRT CIRCUIT OPERATION

Crt Bias and Blanking

The crt has electrostatic focus and electromagnetic deflection. The cathode is directly heated for good efficiency and fast warmup. The intensity is fixed because beam current is maintained constant. Focus adjustment R2140 is provided to obtain best spot focus.

V2120 (crt), Q2142, and Q2146 form a feedback circuit which sets the crt grid voltage to any required level so that the crt cathode current is held constant at about 6 microamperes (through R2156) for single trace, or about 16 microamperes (through R2154) for dual trace (ECG displayed with either or both pressure/pulse and respiration).

The beam current is supplied from only R2156 when either ECG channel or pressure/pulse and respiration channel is off. When both channels are on, CR2153 and CR2154 are off and CR2156 is on, and additional beam current is supplied through R2154.

Crt beam current is off during sweep retrace and multi-trace switching intervals. This is accomplished by positive-going blanking pulses applied through CR2151 and CR2152 to the base of Q2146. The positive pulses turn off Q2146 and Q2142, allowing the collector of Q2142 to go to -50 volts and cutting off the crt beam current. The crt cathode remains near ground potential due to C2146.

CONDITIONER BOARD

CONDITIONER BOARD CIRCUIT FUNCTIONS

The Conditioner board circuits accomplish the following:

1. Provide a heart rate converter that converts the trigger (derived from ECG, pressure, or pulse signals) to dc voltage levels related to the average beat rate.
2. Provide a respiration rate converter that converts the respiration trigger to a dc voltage level related to the average respiration rate.
3. Provide temperature converters that convert the signals from the temperature probes to dc signal levels directly related to temperature.
4. Provide a temperature difference signal (Temp. A-Temp. B) by subtracting the two temperatures algebraically.
5. Provide a systolic-diastolic pressure converter that samples and holds the peak values of systolic and diastolic pressures. The filtered output provides a dc level (for each pressure) that is directly related to the average systolic or diastolic pressure level measured by the pressure transducer.
6. Provide a filter that produces a voltage representative of the mean value of the pressure signal.

7. Provide a means of selecting the desired functions via a readout selector and readout selector decoder using a binary coding system.

8. Provide an alarm system that produces both visual and audible alarms, as well as provision for an external alarm. The alarm operates if the heart or respiration rate goes above or below the limits set by front-panel controls, or if the difference in systolic and diastolic pressures falls below about 5-10 mmHg.

9. Provide an alarm latch that can be reset to clear the alarm either from the front panel or from an external reset switch.

RATE AND TEMPERATURE CONVERTER CIRCUIT OPERATION

Heart Rate Converter

The Heart Rate Converter is basically a one-shot multi (multivibrator) that is fired at every heart-beat. The one-shot multi output controls two CMOS analog switches that gate either ground or -12 volts into the four-pole filter. The filter output ranges between 0 volt for no heart beat to 3 volts for a beat rate of 300 per minute, or more.

U1312B is a 1-millisecond one-shot multi that receives its signal from the Selected Trigger. When U1312B receives a positive trigger pulse, Q output (pin 5) goes HI for 1 millisecond. This closes switches U1313C and D for 1 millisecond, shorting out C1316, the timing capacitor for U1312A. At the end of the 1-millisecond timing cycle, when pin 5 of U1312B goes LO, U1312A timing cycle starts.

U1312A is a 200-millisecond one-shot multi. Its output (pin 13 or TP1317) steps HI at the start of the timing cycle. This HI at pin 13 closes switch U1313B, connecting -12 volts (through R1322) to the input of the four-pole filter (U1335B, U1335C, and associated circuitry). The filter output is therefore proportional to the average rate of the 200-millisecond pulses.

If another trigger signal arrives before the end of the 200 millisecond timing cycle from U1312A, a new 1-millisecond step at U1312B causes U1313C and D to short out C1316 and retrigger U1312A, starting a new timing cycle.

If the input beat rate exceeds 300 beats-per-minute, U1312A pin 13 stays on and the filter input (junction of R1333-C1331) holds at +6 volts. The filter output stays at +3 volts (3000 millivolts) which is divided by 10 in the Readout Selector circuit. This produces a DVM reading of 300 (300 beats-per-minute).

If the beat rate is over 300 per minute, U1312A pin 4 stays LO and enables U1326B so that additional 1-millisecond pulses from U1312B pin 5 will trigger U1326B, producing an overrange signal to the switching circuit to flash the display. The display reads out 300 beats-per-minute maximum because the filter output can never go above +3 volts.

The filter is a four-pole Butterworth filter with each of the poles having a 1-second time constant. U1335C is an inverting feedback amplifier which also serves as one of the filter poles (R1334-C1334). U1335B is a follower which serves as part of pole 4 of the filter.

The first pole of the filter consists of R1333 in parallel with either R1322 or R1323 (depending on which of the CMOS switches is closed), and C1331.

Components R1321, CR1321, and CR1322 prevent U1313B pin 4 from dropping below -7 volts.

Heart Rate adjustment (R1315) sets the time (200 ms) that the Q output (pin 5 of U1312A) is HI, in order to calibrate the Heart Rate Converter.

Respiration Rate Converter

The Respiration Rate Converter circuit is identical to the Heart Rate Converter circuit, with a couple of exceptions. One-shot multi U1342B has a period of 400 milliseconds instead of 200 milliseconds, and U1335D has a gain of 0.25 instead of 0.5. The differences cause the DVM signal to represent up to a maximum of 150 (breaths/minute) instead of 300 (beats/minute) and the overrange to occur at 150 instead of 300.

+1.76 V Supply

The +1.76 V Supply is derived from the +2.5 V reference supply on the Main board via J1100, pin 30. U1406C is a follower that provides a high-impedance load to R1435, and a low impedance out to the temperature circuitry. R1435 adjusts the temperature span by setting the probe supply to +1.76 volts.

Temperature A Converter

The Temperature A Converter circuit converts the probe temperature to a voltage that can be used by the DVM. The temperature probe contains two thermistors and produces, with some external circuitry (the +1.76 V Supply and R1404-R1403), a linear voltage-vs.-temperature curve. The linear range is -5° to +45°C (+23° to +113°F).

U1406A is an impedance matching feedback amplifier, to match the probe impedance to the other circuitry.

U1406B provides the correct amplification to produce 10 millivolts/degree to the DVM. The °F and °C ranges require different amplification (°F is 1.8 times °C). Resistors R1418 and R1429, in conjunction with the °C/°F switch, provide that amplification change.

Resistors R1409, R1424, R1425, R1426, and R1427, in conjunction with the °C/°F switch, provide the 32° offset difference for °C and °F ranges.

Resistor R1425 calibrates the °F range, and R1427 calibrates the °C range (fine adjustment of offset).

Components U1420C, U1420D and R1417-R1418-R1419 provide the overrange detection circuit. U1420C and D are comparators. The input voltages are set to the ends of the temperature ranges. If the temperature goes beyond the linear range, the output of U1420C or D goes LO, causing pin 10 of U1457C to go HI. This HI to the switching circuit causes the display to flash.

A no-probe detection circuit is actuated via an extra set of contacts on the temperature probe input jack, J1401. If the probe is not connected, pin 12 of U1406D goes HI. This produces a HI at pin 14 of U1406D which is used to blank the readout display.

Temperature B Converter

This circuit operates the same as the Temperature A Converter circuit, except that the circuit numbers are different.

Temperature Difference Amplifier

U1445 is a differential amplifier, providing an accurate output signal equal to temperature A minus temperature B. R1441, R1443, R1446, and R1447 are 0.1% resistors to provide a highly accurate output signal.

ΔT Zero adjustment R1445 compensates for U1445 input offset voltage and is adjusted to make the A-B readout equal to the value calculated from the Temperature A and Temperature B readout values.

Temperature Selector

This circuit selects any one of three temperature signals for the digital display. It also selects the appropriate temperature overrange and no-probe signals.

CMOS analog switches U1452A, B and C/D are closed to connect Temperature A, Temperature B, or Temperature A-B signal to the DVM circuit.

When TEMPERATURE A front-panel readout switch is pushed in, pin 3 of U1147A is HI (the HI comes from pin 11 of U1133D on the Readout Switching and Pressure Converters diagram). Since TEMPERATURE B is not pushed in, pin 5 of U1147B is LO. Thus, pin 13 of U1451 is LO and pin 12 is LO (due to pin 1 of U1451A being HI). This causes pin 11 of U1451D to go HI, closing switch U1452A and connecting the Temperature A signal to the DVM circuit.

When TEMPERATURE B switch is depressed instead of TEMPERATURE A, U1452B closes (due to pins 8 and 9 of U1451C being LO) and connects the Temperature B signal to the DVM circuit.

When both TEMPERATURE A and TEMPERATURE B switches are pushed in, both pins 1 and 2 of U1451A are LO, pin 3 is HI, U1452A and B are open, and U1452C/D is closed connecting Temperature A-B signal to the DVM circuit.

Temperature overrange signal is gated through U1456C or B to pin 4 of U1457B. Selecting temperature A causes pin 8 of U1456C to go HI gating the Temperature A Overrange signal to pin 4 of U1457B. Likewise, selecting Temperature B causes pin 6 of U1456B to go HI gating the Temperature B Overrange signal to pin 4 of U1457B. Selecting temperature A-B enables both U1456B and C, gating either Temperature A or B overrange signal to pin 4 of U1457B.

U1456A and D and U1457A operate similarly to the overrange selector for selecting the Temperature A and B No Probe Blanking signal.

PRESSURE CONVERTER CIRCUIT OPERATION

The Systolic/Diastolic Converter is a sampling circuit followed by a two-pole filter. This circuit determines the peak and valley values of the pressure waveform, and through the sampling and filter system, converts these pressure levels to voltage to be read by the DVM circuit.

Systolic/Diastolic Converter

U1230B and U1240C are trigger circuits that tell when to take the sample. Switches U1231C and D are intermediate sample and hold switches, U1231A and B are the output sample and hold switches, and C1233 and C1253 are the final storage capacitors that provide signal to the filter.

When the incoming pressure signal (from pin 8 of U1206C) is rising, pin 10 of U1240C rises. The rise at pin 10 causes pin 8 to rise. Diode CR1244 conducts and charges C1242 to the value of the rising signal.

During this period of rising input signal, since pin 13 of U1240D is HI, pin 14 goes HI and switch U1231D closes. Thus, the rising signal at pin 3 of U1230A (voltage follower) charges C1231 to the input level.

As long as the input pressure signal is rising, pin 7 of U1240B is HI, pin 1 of U1240A is LO, and switches U1231B and C are open.

At the peak of the rise (systolic), C1231 is now charged to that peak level (a sample is taken).

Now when the pressure signal starts to fall, pin 8 of U1240C goes LO because pin 9 is held at the highest level by C1242 while pin 10 falls. Diode CR1244 turns off, pin 14 of U1240D goes LO, opening switches U1231A and D. The sample is now stored in C1231. Since there is no R associated with C1231 (except leakage current in U1230C), C1231 holds the highest value of the pressure signal.

As the pressure falls to the value remaining on C1246, pin 5 of U1240B falls, pin 7 falls, CR1248 turns on, and C1246 charges toward the pressure signal level. As pin 7 of U1240B falls, pin 1 of U1240A goes HI, closing switches U1231B and C. C1251 now charges toward the pressure input signal level via U1230B. At the same time, since U1231 B is now closed, the voltage on C1231 is transferred to C1233 and the systolic sample is fed to the two-pole filter U1236A and associated circuitry.

Since U1231A is open, the previous diastolic sample remains connected to the two-pole filter, U1236D and associated circuitry.

When the input pressure signal reaches the lowest value, C1251 is charged to that value.

As the input pressure now starts to rise, pin 7 of U1240B goes HI because pin 6 is held to the lower level by C1246 while pin 5 rises. Diode CR1248 turns off, pin 1 of U1240A goes LO, switch U1231C and B open, and the diastolic sample is now the voltage on C1251.

When the pressure rises to the value remaining on C1242, pin 8 of U1240C again goes HI, pin 14 of U1240D goes HI, switch U1231A closes, the voltage on C1251 is transferred to C1253, and the diastolic sample is fed to the two-pole filter U1236D and associated circuitry.

U1231D again closes and a new cycle starts.

Output from the two-pole filters is fed to the pressure alarm circuit and to a pair of switches (U1233A and B). These switches are controlled by the Systolic/Diastolic Selector via pins 1 and 2 of U1177A. The switch outputs are tied together and fed to pin 5 of the Readout Selector, U1175.

When the Systolic/Diastolic function is selected, the Systolic/Diastolic levels are multiplexed out to the DVM.

The circuit responds to the peak and valley values (systolic and diastolic) while rejecting normal diastolic notch level changes. The circuit will capture each systolic/diastolic peak, regardless of whether it is larger or smaller than the previous peak. This is due to action of R1242-C1242, R1246-C1246, and the intermediate sample and hold circuits.

The discharge rates of C1242 (systolic) and C1246 (diastolic) are such that the systolic and diastolic switching points are as shown in Fig. 3-11.

Resistors R1243 and R1247 ensure that whenever there is no pulsatile pressure (systolic minus diastolic = 0), all output levels decay to the static incoming pressure.

Mean Pressure Filter

The Mean Pressure is a four-pole passive filter consisting of U1206A, U1206B, and associated components.

The four-pole filter is designed to provide an accurate mean value of the pressure signal while holding ripple to 1 mmHg or less.

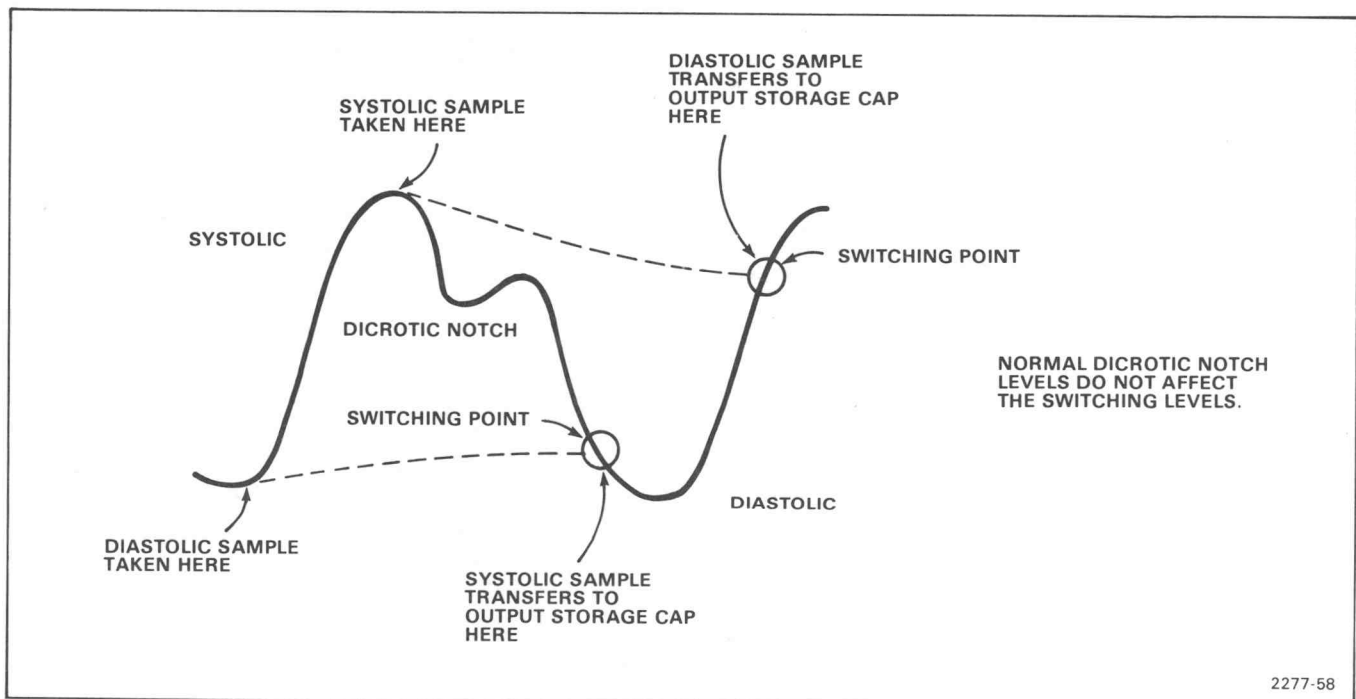


Figure 3-11. Systolic/diastolic switching points.

The operational amplifiers provide impedance matching: U1206C presents a high-impedance load to the pressure signal attenuator and limiter circuit, and low impedance out to the first pole of the filter. Since the impedance of the second pole is too high to drive the third pole, U1206B provides the impedance interface. U1206A provides the low impedance interface to drive the readout selector input, pin 6 of U1175.

Pressure Input Buffer

U1206C provides buffering between the pressure wave and the systolic/diastolic converters and mean filter. Components CR1203, CR1204, and R1203 make up a negative pressure limiter. All of the filters in the pressure converter circuits use polarized tantalum capacitors (ground reference). The negative pressure limiter circuit prevents excessive reverse voltage on these capacitors.

READOUT SWITCHING CIRCUIT OPERATION

5

The Readout Switching circuit is designed around the Readout Selector U1175 and the Readout Selector Decoder U1146. These devices are controlled by binary lines A, B, C, and D. Each of the binary lines is actuated from a number of sources: the Readout switch, the LOW RATE LIMIT (PUSH) switch, HIGH RATE LIMIT (PUSH) switch, and ZERO (PUSH) switch. See Table 3-2 for the binary code, decimal equivalent, and function.

When the HIGH RATE LIMIT and LOW RATE LIMIT knobs are not pushed in, pins 12 and 13 of U1133D are both LO. Therefore, pin 11 of U1133D is HI (+7 V). This +7 volts is applied to the Readout switch (S1135). Pushing one of the buttons on the Readout switch applies +7 volts (from pin 11 of U1133D) to one or more of the binary

lines (A, B, or C) to select the desired function in both U1146 and U1175. For example, if HEART RATE/MIN button is pushed, +7 volts is applied to binary lines A and B.

In U1146, the HI on A and B produces a HI on pin 15 (HEART RATE). In U1175, the HI on A and B connects pin 12 to pin 3, connecting the heart rate signal (dc level) through to the DVM via R1221, R1222, and U1223D.

Integrated circuit U1149 is an AOI (and-or-invert) gate. This gate is the Overrange Gate. If an overrange signal (HI) is applied to one input of an AND portion of the gate, and if that function has been selected (making the other input to this AND gate HI), pin 3 goes LO. This LO on pin 2 of U1151A enables the Rapid Update Trigger Generator.

The same LO, at pin 5 of U1151B enables one-shot U1179A to produce 100 ms of readout blanking every 200 ms update, thus causing the display to flash for overrange indication.

The Rapid Update Trigger Generator consists of a programmable uni-junction transistor Q1152 and its associated circuitry. The trigger generates a pulse every 200 milliseconds. That pulse goes to the DVM which changes the normal updating from once/second to 5 times/second. When there is a HI on pin 28 of J1100 (the Update line) update occurs once/second. A LO on Update causes rapid update.

Rapid update can also come from a LO on pin 4 of U1133B.

TABLE 3-2
Readout Switching Logic

Readout Selector Decoder U1146						Readout Selector U1175				
D	C	B	A	D E C	Function	C	B	A	D E C	Function
LO	LO	LO	LO	0	Inhibits U1175 Blanks Display	LO	LO	LO	0	Low Limit
LO	LO	LO	HI	1		LO	LO	HI	1	High Limit
LO	LO	HI	LO	2	TEMP	LO	HI	LO	2	Temp
LO	LO	HI	HI	3	Heart Rate	LO	HI	HI	3	Heart Rate
LO	HI	LO	LO	4	Resp Rate	HI	LO	LO	4	Resp Rate
LO	HI	LO	HI	5	Syst-Diast	HI	LO	HI	5	Syst-Diast
LO	HI	HI	LO	6		HI	HI	LO	6	Mean
LO	HI	HI	HI	7	Zero (Press)	HI	HI	HI	7	Zero (Press)

U1133B gets its input from either of two sources: pushing the readout ZERO sets up a binary ABC to the decoder. Decimal 7 (pin 4 of U1146) goes HI and produces a LO at pin 4 of U1133B; or pushing either LOW RATE LIMIT or HIGH RATE LIMIT puts a LO on pin 12 or pin 13 of U1133D. Pin 11 of U1133D goes LO, pin 12 of U1147E goes HI, and pin 4 of U1133B goes LO.

Therefore, pushing readout ZERO or pushing either HIGH RATE LIMIT or LOW RATE LIMIT causes rapid update. At the same time, pushing LOW RATE LIMIT removes the HI from Readout switch S1135, making binary lines A, B, and C LO, gating the low limit signal (from U1521D pin 14 in the Alarm circuit) through U1175 to the DVM.

Pushing HIGH RATE LIMIT removes the HI from binary lines B and C and puts a HI on line A, gating the HI limit signal (from U1521C pin 8 in the Alarms circuit) through U1175 to the DVM.

The Pressure Overrange Detector consists of U1123B and D and associated circuitry. The detector is a pair of comparators that compare the incoming pressure levels (dc) to fixed voltages set by the divider R1122, R1123, and R1124. The pressure signal is direct pressure and is not attenuated. The comparison level is such that an overrange signal is produced if the display (even a spike) goes off screen.

Since the filtered pressure signals are average signals, even an off-screen spike might change the average significantly.

If the Pressure Overrange Detector produces an overrange signal (HI) to pin 12 of U1149, and if pressure has been selected (a HI on binary line C), U1149 output (pin 3) goes LO and provides a rapid update signal from Q1152, and a flash signal via U1151B, U1179A, and U1180.

The Systolic/Diastolic Selector (a three-state switch) consists of U1177A, U1177B, and U1179A. The selector changes states each time a positive-going signal arrives at pin 11 of U1177B.

If the Systolic/Diastolic (pressure) has been selected (HI on pin 6 of U1146), pin 5 of U1180 enables the blanking gate. At the same time, the HI is applied to pins 8 and 9 of U1176C. Now pin 10 of U1176C goes LO, causing pin 6 of U1151B to go LO. Pin 5 of U1151B goes LO if pin 3 of U1149 goes LO on overrange. A LO at either U1151B inputs produces a HI at pin 3 of U1179A and this one-shot multi is enabled. When a positive-going edge comes in on the Sample line from the DVM, (into pin 2 of U1179A) the one-shot U1179A is fired (pin 4 steps LO). This LO is applied to pin 11 of U1180 causing a blanking (LO) signal at pin 58 of J1100.

The DVM Sample signal also causes U1177A and B to change states to provide the correct display sequence and blanking intervals.

Integrated circuits U1177A, U1177B, and U1176D make up a three-state multi to switch the Systolic/Diastolic gates (U1223A and B) to alternately read out systolic and diastolic pressures, and provide blanking between sets of readings. U1179A provides a 100-millisecond blanking interval between systolic and diastolic readings.

Gates U1223C and D provide switching to attenuate all of the Readout Selector output signals, except temperature, by a factor of 10, since these signal levels are ten times the level required by the DVM.

When temperature is selected (HI on binary line B), pin 2 of U1146 is HI, U1223C closes and U1223D opens, thus feeding the unattenuated temperature signal out of the Readout Selector to the DVM.

When any signal other than temperature is selected, pin 2 of U1146 goes LO, U1223C opens, U1223D closes, and the signal out of the Readout Selector is divided by ten before going to the DVM.

Sign Enable Gates

U1133A, U1133C, and U1147D determine whether the sign information in the DVM is presented to the readout.

When temperature or pressure is being measured, a + or—sign must be displayed. For rate, the sign has no meaning so sign information is not displayed.

When temperature is selected, the HI at Pin 9 of U1133C (from pin 2 of U1146) causes a LO on the Sign Enable line to tell the DVM to display the sign information.

When pressure or respiration rate is selected, binary line C is always HI, indicating that one of the last four states (4, 5, 6, or 7) has been selected. The LO on pins 1 and 2 of U1133A make pin 3 of U1133A HI, again causing a LO on the Sign Enable line.

Decimal Point Selection

When temperature is selected, the HI on pin 14 of U1147F causes a LO at pin 15. This signal is fed to the DVM via pin 29 of J1100 and enables decimal 2.

ALARM CIRCUIT OPERATION

The Alarms circuit consists of three Alarm Detectors (Rate, Pulse and Apnea) and an Alarm Latch, Output, & Reset circuit.

The Alarm Detectors determine when an alarm has occurred and sends a LO signal to the U1547A input. The alarm Latch, Output, & Reset circuit holds the alarm command from the Alarm Detectors and turns on the ALARM light and the audible alarm. The audible alarm sounds until reset or until the alarm condition ends.

The Reset circuit has a built-in 45-second time delay so that the audible alarm stops, but the ALARM light remains on until the alarm condition is ended. After 45 seconds, if the alarm condition still exists, the audible alarm again sounds.

Rate Alarm Detector

U1466B and associated circuitry provide a reference voltage (+2.4 volts for heart rate or 1.2 volts for resp. rate) to the HIGH RATE and LOW RATE LIMIT controls. The HIGH RATE LIMIT control provides a range of 90 to 240 beats/minute for heart rate or 45 to 120 breaths/minute for respiration rate. The LOW RATE LIMIT control produces a range of 0 to 150 beats/minute for heart rate or 0 to 75 breaths/minute for respiration rate.

The Rate Limit controls set voltages at pin 10 of U1521C and pin 12 of U1521D. These two feedback amplifiers are voltage followers to provide low impedance drive to the Readout Selector (U1075) inputs pins 13 and 14 and also to drive the comparators U1521A and B. The Low Limit and High Limit signals going to the Readout Selector provide DVM readout of the rate alarm limits when the HIGH or LOW RATE LIMIT knob is pushed in. This eliminates the control linearity problems of reading limits from limit-control position relative to front-panel scales.

The same voltages that drive the Readout Selector are fed to comparators U1521A and U1521B. These comparators compare the reference voltage level from the Rate Limit controls with the rate signal (dc level from the Rate Converters) from pin 7 of U1335B or pin 1 of U1335A.

Whenever the heart or respiration rate signal goes below the limit set by the LOW RATE LIMIT control, or above the limit set by the HIGH RATE LIMIT control, U1522A is enabled. Pin 3 of U1522A goes HI, CR1522 turns off, and C1522 charges toward +7 volts. When the threshold at U1522B is crossed, pin 4 of U1522B goes LO. Pin 5 of U1547A goes LO and pin 1 of U1547A goes HI causing flip-flop U1176 to latch in the alarm condition. Once U1176 is latched to the alarm condition, it holds that condition until reset.

The rate alarm can be disabled by turning the LOW RATE LIMIT control fully counterclockwise. This places -7 volts on pin 6 of U1522B, inhibiting U1522B.

Pulse Alarm Detector

The pulse-alarm signal is disabled in the out position of the PULSE ALARM button. In the out position, -7 volts is applied to pin 12 of U1522D, which inhibits U1522D, preventing the pulse alarm from reaching U1547A.

When no pulse alarm condition exists on the inputs to U1123C or U1151C, the outputs (pin 8 of U1123C and pin 10 of U1151C) are held LO. CR1541 and CR1542 are turned on, pin 13 of U1522D is held LO, inhibiting U1522D.

When the Pulse channel is selected, the pressure signal is disabled. Therefore, the pressure signal (dc level) out of the Systolic/Diastolic Converter is zero. Pin 9 of U1123C is more negative than pin 10 due to R1536/R1537 divider so pin 8 of U1123C is HI and CR1542 is turned off, permitting a pulse alarm from U1151C. If the pulse trigger signal ceases, pin 9 of U1151C remains LO and pin 10 remains HI, thereby shutting off CR1541. This allows C1543 to charge toward +7 volts, thus enabling U1522D and setting the flip-flop (U1176) by way of U1547A.

If the Pulse channel is off, pin 8 of U1151C is LO. Regardless of the condition of pin 9 of U1151C, pin 10 is HI and CR1541 is turned off.

If the systolic pressure falls below a level that is 5 to 10 mmHg above the diastolic pressure, pin 8 of U1123C goes HI. CR1541 turns off and C1543 charges toward +7 volts. With the PULSE ALARM switch in (on), both inputs of U1522D are HI, pin 11 is LO, and U1547A is enabled causing the alarm condition to be latched in until reset.

Apnea Alarm Detector

Respiration Trigger pulses turn on Q1551 discharging C1552. This holds pin 1 of U1123A LO and inhibits an alarm output at pin 10 of U1522C. If a Respiration Trigger pulse does not occur within 15 or 30 seconds (set by S1554B), C1552 is allowed to charge to +7 volts through R1554 or R1556. This causes pin 1 of U1123A to go HI, producing a LO at pin 10 of U1522C, which indicates an alarm condition.

Alarm Latch, Output & Reset

When an alarm condition is detected, pin 1 of U1547A goes HI, which sets pin 3 of U1176 HI, turning on the ALARM light and the audible alarm.

Pin 3 of U1176 remains HI until the reset button is pushed in. When pin 1 of U1547A goes HI indicating an alarm condition, pin 11 of one-shot multi U1179B goes HI releasing the reset. Pressing the ALARM RESET button makes pin 9 of U1179B LO and triggers a 45-second pulse at pin 12 of U1179B. This turns on Q1571, causing pin 1 of U1176A to go HI and pin 3 to go LO. The LO on pin 3 of U1176A causes pin 13 of U1547B to go HI, turning off the audible alarm. At the end of the 45-second reset pulse, if pin 1 of U1547A is still HI, pin 3 of U1176A goes HI and again turns on the audible alarm.

The ALARM light is controlled by Q1594. Q1594 is held on by the HI on pin 1 of U1547A and/or pin 3 of U1176A. If U1176 has been reset, but the alarm condition continues (pin 1 of U1547A HI), the ALARM light is held on via R1592. If the alarm condition ends but U1176 has not been reset, the ALARM light remains on (via R1593) until the reset button is pushed in.

When the PULSE ALARM button is out, a negative step from C1563, via R1563, pulls Q1571 base LO, placing a HI on pin 1 of U1176A, resetting it. Similarly, when the LOW RATE LIMIT control is turned fully counterclockwise to RATE ALARM OFF position, U1176 is reset via C1562 and R1562. C1581 and R1581 provide the same function when the APNEA ALARM button is set out (off).

Q1576/Q1577 is a current amplifier which provides a 15 mA ALARM output to the rear-panel jack or to the optional recorder.

DVM BOARD ④

DVM BOARD CIRCUIT FUNCTIONS

The DVM circuit accomplishes the following:

1. Converts analog input signals from the Conditioner board to digital signals which drive the gas-discharge readout elements.
2. Detects polarity of analog input signals and sets the Polarity Switch circuit for a positive input to the DVM.
3. Provides digital signal to blank digital display during certain intervals that could give an incorrect or unusable display.

4. Suppresses leading zeros.

5. Provides drive for decimal point and sign display.

6. Provides two clock signals for sample and display.

7. Provides power supplies for DVM and gas-discharge readout elements.

DVM CIRCUIT OPERATION

The DVM circuit consists basically of a Dual-Ramp A/D Converter Subsystem U920 (type MC 1405) and a 3 1/2 Digit A/D Logic Subsystem U947 (type MC 14435).

Analog-to-digital conversion is accomplished by the dual-ramp method. An internal positive-going (up) ramp is generated when the Ramp Control input to U920 is LO. See Fig. 3-12. When the ramp current reaches the threshold level of the internal comparator, a HI signal is sent to the comparator input of U947 causing its counter to start counting from zero. The ramp continues going up until a count of 1000 is reached, at which time the Ramp Control line goes HI and starts a down ramp. The slope of the up ramp is determined by the analog voltage level at the input of U920, while the slope of the down ramp is fixed by the reference voltage into U920.

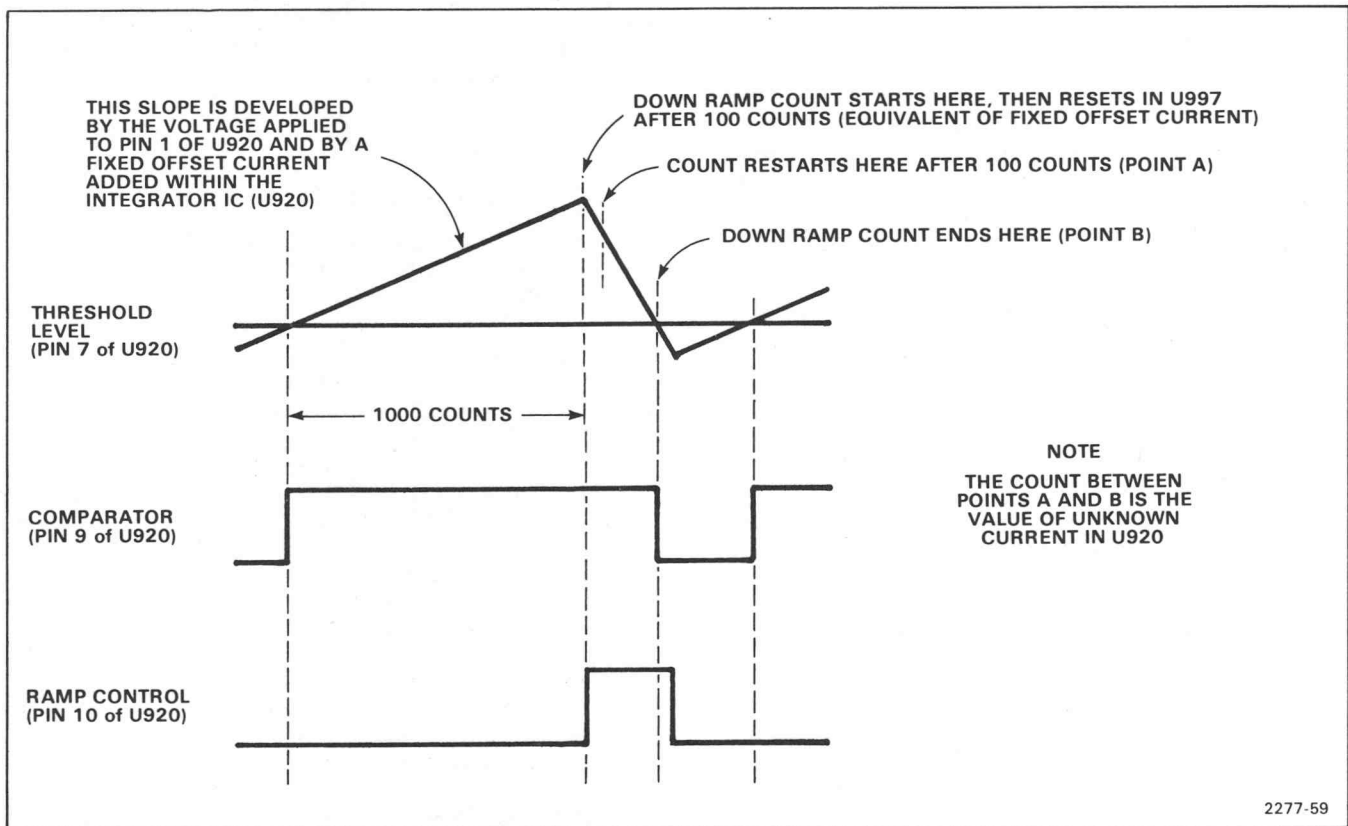


Figure 3-12. Basic A/D dual-slope waveform.

To provide ramp runup even when the unknown voltage is zero, a fixed offset current is added to the unknown. To compensate for this added offset current, the down ramp count is delayed by 100 counts (the equivalent of the fixed offset current on the up ramp).

The number of counts back down (after the 100-count delay) gives the value of the unknown current, and therefore the unknown voltage.

Polarity Switch

Polarity switching provides the correct signal polarity into the DVM.

The Polarity Switch consists of U925A, B, C, and D, and a differential-input amplifier. These switches are controlled via Q990 and Q992, which are level shifting inverters. The level is shifted because of the different logic levels of U925 (+ and -7 volts) and U1025B (+5 volts and ground).

U925 is a double-pole, double-throw, electronic switch that feeds the differential amplifier input. The amplifier, U926-U927 is an impedance interface between the voltage divider (R1221-R1222, via U1223D on diagram 5), and the low-impedance input to differential amplifier U928.

U1025B controls the input-polarity switches. The required polarity (always positive on pin 1 of U920) is determined by a number of devices that will be discussed later.

Digital Voltmeter

Pin 7 of U920 is the output of the dual-slope integrator. When a sampling cycle starts, pin 7 rises linearly (ramp). See Fig-3-12. The unknown input voltage controls a current source that determines the current (including the fixed offset current) into the integrating capacitor C939.

The ramp runs up for exactly 1000 cycles (determined in U947). When the count has reached 1000 clock cycles for the up-ramp duration, the ramp control switches state, pin 7 of U947 goes HI, pin 8 of U935B goes HI, pin 10 of U920 goes HI and switches the integrating circuit to the reference-current source (opposite polarity) and the ramp starts down.

When the down ramp reaches the threshold level, the count stops but the ramp continues below the threshold level. During this time the count is transferred to the output multiplexer circuit within U947. A number of things happen in U947, including count reset. Ramp Control is also switched back to provide a LO on pin 10 of U920 to start another up ramp.

If the input polarity to the DVM is incorrect (negative), the external 100-count delay (U1021) does not expire by the time pin 9 of U920 goes LO. The down ramp has crossed the threshold level before the 100-count delay has expired (both in U947 and U1021).

Therefore, U946B prevents the count in U947 from stopping by holding pin 5 of U947 HI. This ensures that the 100-count delay on the down ramp is complete in U947.

When the external 100-count delay expires, pin 5 of U946B goes LO. Since pin 9 of U920 has gone LO prior to this time, pin 4 of U946B goes HI. The HI at pin 4 of U946B is inverted by U934F to a LO at pin 10 of U947. This LO terminates the count. After a 50 microsecond delay (C936-R936), the HI on pin 10 of U935, B resets the Update flip-flop. Now, Ramp Control (pin 10 of U920) goes LO, and the ramp again starts up.

U946B gets its LO on pin 5 from the Q output of flip-flop U935A.

When the external 100-count delay (U1021A-U1021B) completes its count, pin 14 of U1021B goes LO. This transition produces a positive edge from pin 3 of U946A, which resets U935A (because data input pin 5 is held LO).

U935A gets set from pin 11 of U946D at the beginning of every cycle and reset at the end of the 100-count delay.

When the 100-count delay expires (indicated by U935A resetting), pin 2 (\bar{Q}) goes HI. This HI is a clock input to U1023B, and either sets or resets U1023B depending on the state of the data input (pin 9) which comes in via inverter U946C from pin 9 of U920. If pin 9 is LO when the 100-count delay expires, it means that U920 input sees a negative signal. This condition sets U1023B pin 13 (Q) HI and pin 12 (\bar{Q}) LO.

This LO on \bar{Q} indicates to U1025A that the polarity is not correct, so the Sample Clock continues to be selected (U1025A pin 1 HI).

If pin 9 of U920 is HI when the 100-count delay expires (meaning that the input signal is positive), pin 9 of U1023B is LO. This causes U1023B to reset, placing a LO on the Q output and a HI on the \bar{Q} output.

The HI on \bar{Q} tells the clock selector (U1025A) that the sign is okay. U1025A changes states, causing the Display Clock to run and the readout to display the information being multiplexed out of U947.

If the input polarity is negative, the clock cycle counter U1023A allows only one change of sign. After the sign has been changed once, and if the sign is still not correct on the next sample, U1023A forces the clock to change back to display by resetting U1023B. The result is a displayed zero, because whenever pin 9 of U920 goes LO before the external 100-count delay expires, U947 is always allowed to run out its 100-count delay and read zero.

Anytime there is a negative polarity input that cannot be made positive (no matter how many times the polarity is switched), the circuit is allowed to switch once, per cycle, thus displaying zero. With zero input to the circuit board, the result is that the display will be zero, but the + and— sign will be displayed alternately on the display (this condition is caused when the DVM Zero adjustment R920 is set too low).

Leading Zero Suppression

Multiplexing is from right to left. U951B is used to store information about digit 3 zero suppression to determine whether to display or suppress a digit 2 zero.

Whether a digit 3 zero gets suppressed or displayed depends on whether digit 4 (the 1/2 digit) is displayed. The 1/2-digit information remains on pin 10 of U947 during the entire display interval.

To determine whether to suppress a digit 2 zero, the system goes through the first multiplexing cycle and blanks the display via U951A.

There is an interval when pin 4 of U946B is HI during sampling. This HI sets U951A, causing display blanking via U952B. The display remains blanked during the multiplexing cycle.

During this blanking interval, U951A can either inhibit or toggle to the opposite state. The K input comes from $\overline{DS1}$ and since $\overline{DS1}$ is active LO, U951A sees LO on both J and K inputs. This is the inhibit mode, so the display remains blanked. When $\overline{DS2}$ goes LO, $\overline{DS1}$ goes HI, which is the condition for U951A reset, but reset cannot occur until the next clock edge at clock input pin 3. That clock edge does not occur until the end of digit 2. So, on the first multiplexing cycle, digits 1 and 2 remain blanked.

Unblanking now allows digit 3 to be displayed, if it is not zero suppressed because of the state of the 1/2 digit.

By the next multiplexing cycle, digit 3 zero suppression is stored in U951B to decide whether or not to blank a digit 2 zero.

The blanking is accomplished through the Ripple Blank input, pin 5 of U975.

The 1/2 digit is on pin 10 of U947 as soon as the down ramp is completed. The 1/2 digit information goes to pin 12 of U973B, (DP3 and DP4 are not used in standard monitors, thus pin 9 and 10 remain LO). Digit select 3 information comes in on pin 11 of U973B.

When all four inputs to U973B are LO, and if the ABCD code is 0 in U975, the Ripple Blanking circuit blanks all of the segments of the digit 3 display, even though the anode has been selected.

If $\overline{DS2}$ (at pin 4 of U973A), DP2 (at pins 2 and 3 of U973A), and \overline{Q} output of U951B (at pin 5 of U973A) are all LO, and the ABCD code is 0, the Ripple Blanking circuit blanks all of the segments at the digit 2 display, even though the anode has been selected.

Update Logic

The update flip-flop U935B receives logic from several sources to start the ramp up (U920), to start the ramp down, and to provide logic to the external 100-count delay (U1025A), the clock cycle counter (U1023A), and the clock selector (U1025A).

In normal operation U935B gets reset once per second from U947.

Update signal coming from pin 22 of J900 provides a LO at pin 9 of U934D. Therefore, pin 11 of U935B goes HI. Since U935B data line is HI at all times, the positive-going edge on pin 11 (clock) sets U935B, causing the ramp control to start the run down.

When in the slow clock (Display) mode, U920 and U947 are still operating as if they were taking a sample. However, because the clock is so slow, the ramp runs up rapidly to saturation, and remains there.

When an Update signal (LO) arrives to set U935B, the ramp control input to U920 switches and the ramp starts back down. As soon as the down ramp reaches the comparison level, the system is forced to go through a cycle of sample clock, and then reverts back to slow (Display) clock. The Update signal occurs every 200 milliseconds whenever update is required.

The external 100-count delay resets U935A at the end of 100 counts.

Anode Drivers

The display anodes A1, A2, A3, and A4 are driven from the Anode Driver circuit, Q955-Q956, Q958-Q959, Q961-Q962, and Q964-Q965.

The Anode Drivers, except A4, are driven by the \overline{DS} outputs of U947. The Anode Drivers are identical (except A4) so only one is described.

When $\overline{DS1}$ at pin 2 of U947 goes LO, Q955 turns on, supplying enough base current to cause Q956 to saturate. When Q956 saturates, A1 (pin 1 of P956) goes to about +165 volts to drive the gas-discharge display anode.

Since Q964 emitter return is grounded, Q964 conducts and Q965 is saturated at all times except when all digits are blanked. This occurs when the bases of Q955, Q958, Q961, and Q964 (bases common) are pulled low by U952B during any blanking interval (when all digits get turned off).

Decoder/Driver

U975 converts the binary-coded-decimal (BCD) information from U947 to the form required to drive the cathode segments of the 7-segment gas-discharge display.

When the segments are not turned on by a signal from U975, the segments are set at about +75 volts by the one-megohm resistors in R976 (B through H). When turned on, the segment drivers pull toward ground and current is controlled in U975. The binary code on A, B, C, and D determines which segments are turned on.

Sign Enable Logic

When Sign Enable is LO (from Readout Selector logic), U977C and B are enabled so that the sign information from pin 15 of U1025B activates one of the Sign Drivers, Q1061 or Q1062.

Sign, Decimal, and 1/2-Digit Drivers

Q982 and Q1061 through Q1069 are cathode-current drivers for the 1/2 digit, the + and—signs, and the decimal points. When the base of one of the driver transistors is pulled HI (to +5 volts), the emitter resistor to ground sets the collector current, thus turning on the desired display cathode at a controlled current level.

Diodes CR982, CR1061, CR1062, CR1065, CR1067, and CR1069 prevent transistor saturation during digit-anode blanking periods. This keeps emitter current (diverted to the transistor base if the transistor is saturated) from affecting the logic lines that drive the transistor bases.

The decimal-point drivers Q1065, Q1067, and Q1069 get their signals from the Readout Selector switching circuitry via J900 and U934A, B, and C.

The 1/2-digit driver Q982 gets its signal from pin 10 of U947.

Clock Circuits

There are two clocks in the digital voltmeter: a Sample Clock that runs only when a sample of the count is being taken; and a Display Clock that runs at a much longer frequency to display the count that has been sampled.

The Display Clock uses an IC timer (U1039) to produce a 1-kHz, asymmetrical, rectangular pulse. Pin 4 of U1039 is used as a gate. When pin 4 is HI, the clock runs; when pin 4 is LO, the clock is off.

The Sample Clock (consisting of Q1031, Q1032, and Q1033) runs at 250 kHz, with Q1031 used as a gate. A HI on Q1031 base turns on the clock. The clock receives its logic from the Clock Selector flip-flop U1025A.

Q1032 and Q1033 form an oscillator. Assuming that Q1033 is turned on, C1032 charges through R1032 toward -12 volts. When the junction of R1032-C1032 reaches -0.6 volts Q1032 turns on, pulling Q1033 base down and Q1033 starts to turn off. The regenerative action causes Q1032 to saturate. Q1033 now turns off. C1032 now charges (in the opposite direction) via R1033 toward -12 volts. The junction of C1032-R1033 pulls Q1033 emitter down until Q1033 turns on again. Q1032 now turns off and a new cycle starts.

The Display Clock signal also provides inter-digit display blanking. When switching from one digit to the next in the same envelope, the display must be blanked briefly to permit deionization of the gas in the readout. This blanking prevents partially lit segments and streamers (blue glow) between digits.

During each Display Clock period, pin 11 of U977D is HI for 250 microseconds and LO for 750 microseconds of the 1-millisecond clock period. This signal from pin 11 of U977D is fed to pin 2 of U951A, which turns off the anode drivers for 250 microseconds at the beginning of each display clock cycle.

Sample Output

Q1043 provides a signal via pin 10 of J900 to the Readout Selector switching circuit to operate the Systolic/Diastolic selector.

+5 Volt Regulator

The +5 volt supply is derived from the +7 volt supply by error amplifier U1001 and pass transistor Q1003 to provide +5 volts for most of the digital devices in the digital voltmeter.

Readout Supply

The Readout Supply uses transformer T1010 to provide -90, +75, +165 volts to the gas-discharge readout display.

T1010 primary is supplied from a voltage (28 volts peak-to-peak) picked off transformer T1972 in the main power supply.

The secondary (T1010) voltages (-90 and +75) are rectified and filtered in the conventional manner. The +165 volts is produced by a voltage doubler circuit (CR1012-C1012-C1013-CR1013).

MAINTENANCE

This section contains information for performing preventive maintenance, troubleshooting, and corrective maintenance for the 413 Monitor.

PREVENTIVE MAINTENANCE

ROUTINE MAINTENANCE SCHEDULE

Table 4-1 is a suggested minimum maintenance schedule for instruments in continuous use. Obvious defects should be immediately remedied.

TABLE 4-1
Routine Maintenance Schedule

	1 Month	6 Months
Inspect Removable Wires and Cables	X	
Inspect Power Cord & Plug	X	
Safety Inspection (see Safety Information in front of manual)		X
Calibration (by qualified service personnel only)		X
Clean Exterior		As Required

OPERATOR INFORMATION

Preventive maintenance to be performed by an operator consists of external cleaning and visual inspection. The following information, also included in the 413 Operator's Manual, is intended for use by both operator and service personnel.

CLEANING

The recommended method of cleaning the exterior surfaces of the monitor is with a cloth or swab dampened with a warm water and mild soap solution. Do not permit liquids to run behind the knobs and pushbuttons or into the connectors.

INSPECTION

Inspect all removable cables, wires, etc. Pay careful attention to the points that frequently bend, as the repeated flexing at these points eventually will cause breakage. Replace frayed or otherwise damaged cables.

Inspect the power cord and plug for damage. Repair or replacement should be performed only by qualified personnel.

CAUTION

Monitors that have been dropped or otherwise abused, should be checked by qualified service personnel to verify all safety features.

CALIBRATION AND SAFETY

Qualified service personnel should check the calibration of this instrument at least every six months. It is also recommended that the electrical-safety features be inspected and leakage current measured every six months. Complete instructions are given later in this section.

WARNING

Electric-shock hazard exists when the instrument covers are removed. Refer servicing to qualified personnel.

SERVICE INFORMATION

Preventive maintenance to be performed by service personnel only consists of external cleaning (see Operator Information above), visual inspection, calibration, and ECG patient-circuit leakage checks.

CABINET REMOVAL

WARNING

Electric-shock hazard exists when monitor is operated with covers removed. Avoid touching exposed connections or components which might be elevated from ground (e.g., some metal-cased transistors).

All ac-line voltage connections are covered and located on the rear panel. Some exposed voltages are, + and -35 V in the vertical amplifier circuit and -50, +175, and +3400 V in the crt circuit.

Disconnect monitor from ac power source and unplug battery plug (P1982) before cleaning interior of monitor or replacing components.

To remove the top cover, remove the two screws on each side, lift up the left side of the cover, then make sure it has cleared the ECG LEAD CHECK terminals and remove the cover from the monitor.

To remove the bottom cover, remove the two screws on each side and pull the cover straight off.

NOTE

Be sure board retainer clip is in place before replacing top cover. See Figure 4-2.

VISUAL INSPECTION

In addition to checking external cables and wires as discussed under Operator Information, the 413 interior should be inspected occasionally. Check for such defects as broken connections, improperly seated semiconductors, damaged circuit boards, and heat-damaged parts.

The method for correcting most visible defects is obvious. However, be particularly careful if heat-damaged components are found because overheating usually indicates other trouble in the instrument. It is important to correct the cause of overheating to prevent recurrence of the damage.

CALIBRATION

Monitor adjustment should be checked at least every six months or 1000 hours. Certain adjustments may be necessary following component replacement as indicated in the Component Replacement portion of this section. Adjustment procedures are located in Section 5, Calibration.

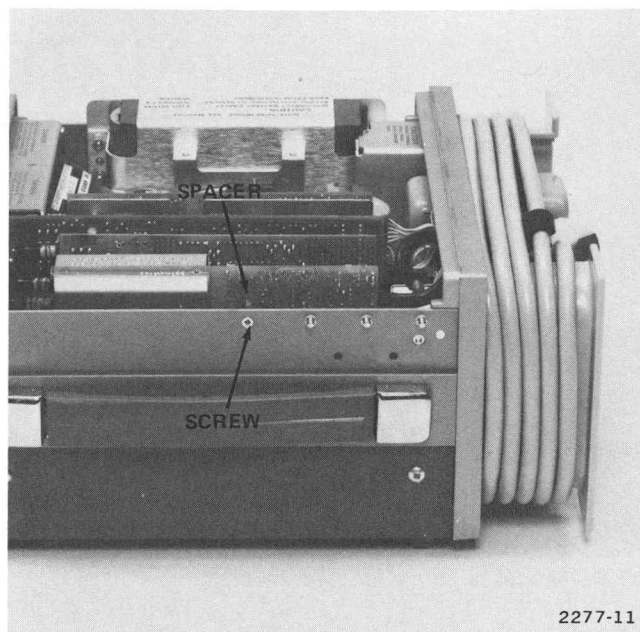


Fig. 4-1. ECG board securing.

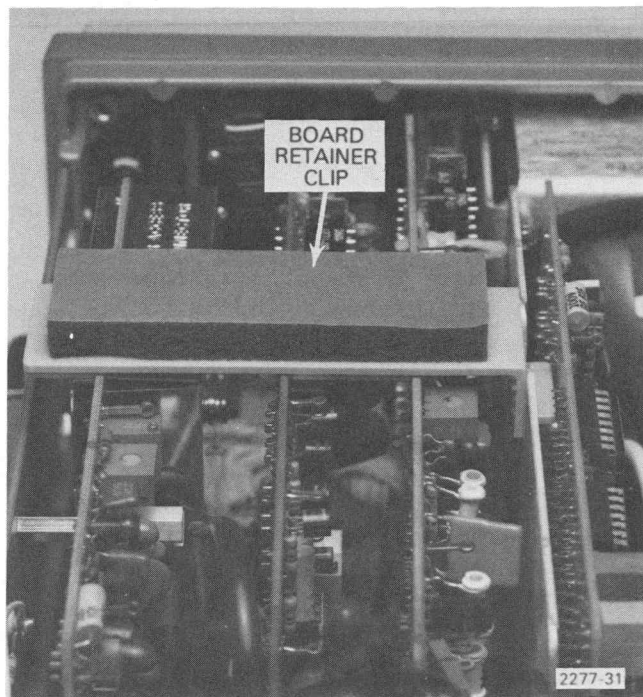


Figure 4-2. Board retainer clip installation.

ECG LEAKAGE CHECK

A leakage check should be made at least every six months or whenever the monitor has been dropped or otherwise abused. Also, check leakage after any repairs.

This check determines the amount of leakage current that could be present between the patient and the ECG circuit of the monitor under either of the following abnormal conditions:

- (1) Monitor is properly grounded and patient is at 120 Vac, 60 Hz, or
- (2) Monitor is not grounded, case is connected to 120 Vac, 60 Hz and patient is grounded.

Test Equipment Required

Use an instrument such as the Model 431 Safety Analyzer, manufactured by Neutrodyne-Dempsey Inc., P.O. Box 1925, Carson City, Nevada.

Leakage Check Procedure

- a. Disconnect monitor from ac power source.
- b. Remove top and bottom covers.

c. CHECK—All plug-in circuit boards are pushed firmly into their mating receptacles.

d. CHECK—All cables are plugged firmly into their mating pins and that they are dressed away from ECG shield, input connector shield and pushbutton switch shafts.

e. CHECK—Screw and spacer securing ECG circuit board are tight. (See Figure 4-1.)

f. CHECK—Plastic board retainer is installed and properly seated at top of circuit boards. (See Figure 4-2.)

g. Replace top and bottom covers. Leakage check is valid only with covers installed.

h. Check ECG-leakage current using procedure supplied by the Safety Analyzer manufacturer.

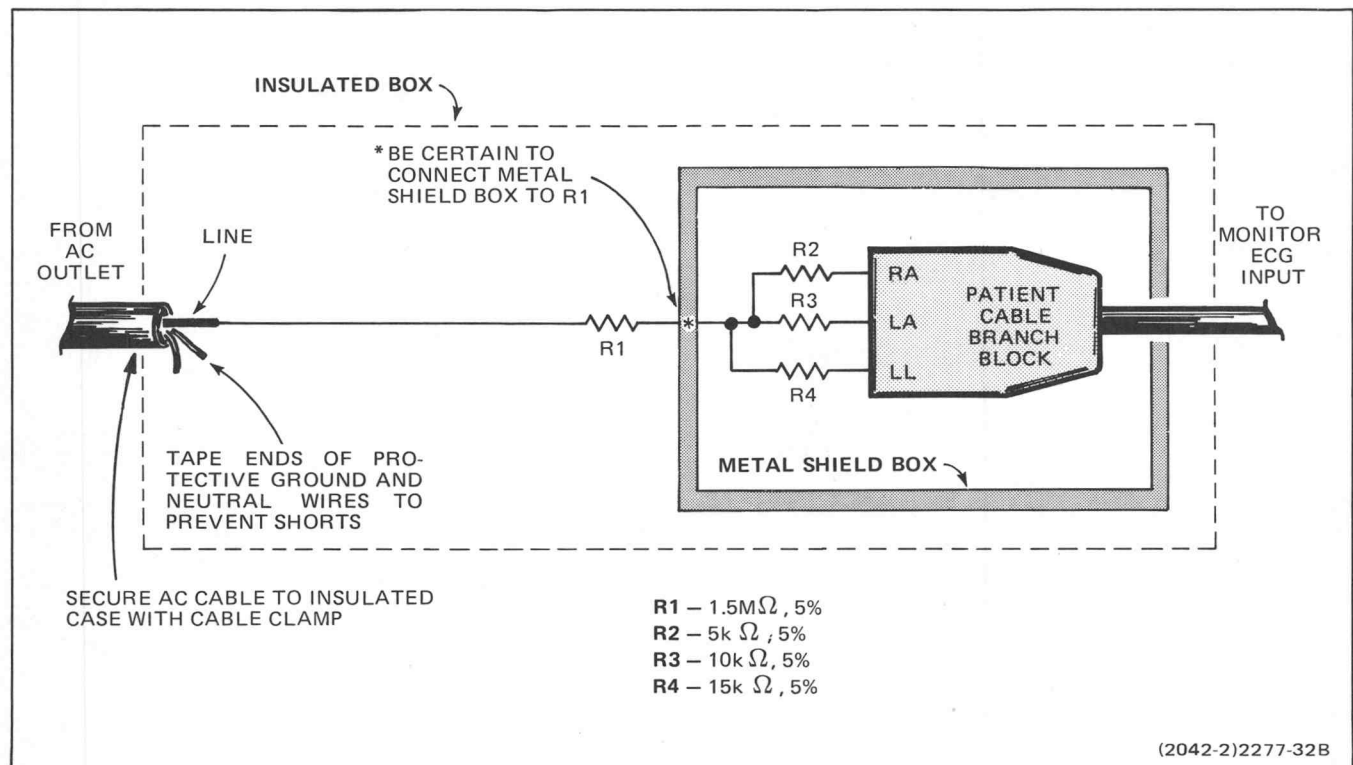


Figure 4-3. CMRR-Leakage test fixture.

TROUBLESHOOTING AIDS

The following is provided to facilitate troubleshooting the 413 Monitor. Information contained in other sections of this manual should be used in conjunction with the following data to aid in locating a defective component. An understanding of the circuit operation is also helpful. See Section 3, Theory of Operation for this information.

SERVICING EXTENDER SET

Servicing Extender Set, Tektronix Part 020-0291-00 is available to aid in troubleshooting and calibration. It provides an extender board and the cables necessary to operate the monitor with any of the plug-in circuit boards extended. Use of the Servicing Extender Set is essential to extend the Conditioner board for making Main board adjustments.

SCHEMATIC DIAGRAMS

Complete schematic diagrams are given on the foldout pages in Section 8, Diagrams and Circuit Board Illustrations. The component number and electrical value of each component in this instrument are shown on these diagrams. (See the first page of the Diagrams and Circuit Board Illustrations section for definitions of the reference designators and symbols used to identify components in this instrument). Important voltages and idealized waveforms are also shown on the diagrams. The portions of circuits mounted on circuit boards are enclosed with heavy solid-black lines.

CIRCUIT BOARD ILLUSTRATIONS

A circuit board illustration is shown in conjunction with each circuit diagram. These are located on the back of the pullout page opposite the associated circuit diagram. Each circuit component and waveform test point shown on the circuit diagram is identified on the circuit board illustration by its circuit number. Circuit number locations are identified with a grid-index system.

ADJUSTMENT AND TEST POINT LOCATIONS

To aid in locating test points and adjustable components called out in the Adjustment procedure, an Adjustment and Test Point Locations foldout page is provided in Section 8, Diagrams and Circuit Board Illustrations.

COMPONENT VALUE IDENTIFICATION

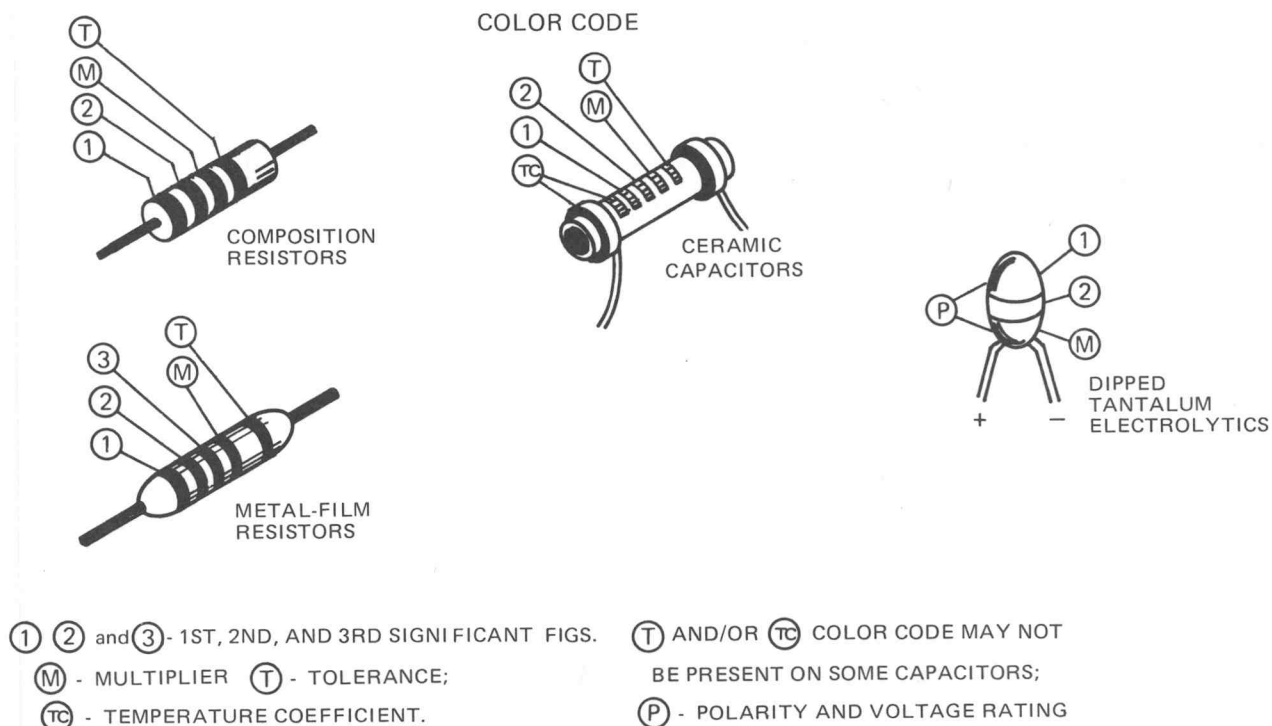
Values of capacitors, diodes, and resistors used in this instrument are identified by direct numerical values or by a color-code scheme. Figure 4-4 shows the color-code and numerical-value schemes used.

SEMICONDUCTOR LEAD CONFIGURATIONS

Typical semiconductor lead configurations are shown in Figure 4-5. Before handling semiconductors or boards containing semiconductors, see the special handling Caution in this section under Component Removal and Replacement, Semiconductors.

TRUTH TABLES

Truth tables are given on pullout pages in the Diagrams and Circuit Board Illustrations section of this manual. These truth tables give the logic state outputs for specified inputs to the various integrated circuits used in the 413 Monitor.



COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER (OHMS)	TOLERANCE	MULTIPLIER (pF)	TOLERANCE		
					OVER 10pF	UNDER 10pF	
BLACK	0	1	---	1	±20%	± 2pF	4VDC
BROWN	1	10	±1%	10	±1%	±0.1pF	6VDC
RED	2	10 ² or 100	±2%	10 ² or 100	±2%	---	10VDC
ORANGE	3	10 ³ or 1 K	±3%	10 ³ or 1000	±3%	---	15VDC
YELLOW	4	10 ⁴ or 10K	±4%	10 ⁴ or 10,000	+100% -0%	---	20VDC
GREEN	5	10 ⁵ or 100 K	±1/2%	10 ⁵ or 100,000	±5%	±0.5pF	25VDC
BLUE	6	10 ⁶ or 1 M	±1/4%	10 ⁶ or 1,000,000	---	---	35VDC
VIOLET	7	---	±1/10%	10 ⁷ or 10,000,000	---	---	50VDC
GRAY	8	---	---	10 ⁻² or 0.01	+80% -20%	±0.25pF	---
WHITE	9	---	---	10 ⁻¹ or 0.1	±10%	±1pF	3VDC
GOLD	---	10 ⁻¹ or 0.1	±5%	---	---	---	---
SILVER	---	10 ⁻² or 0.01	±10%	---	---	---	---
NONE	---	---	±20%	---	±10%	±1pF	---

(1862-74) 2277-34

Figure 4-4. Capacitor and resistor value identification.

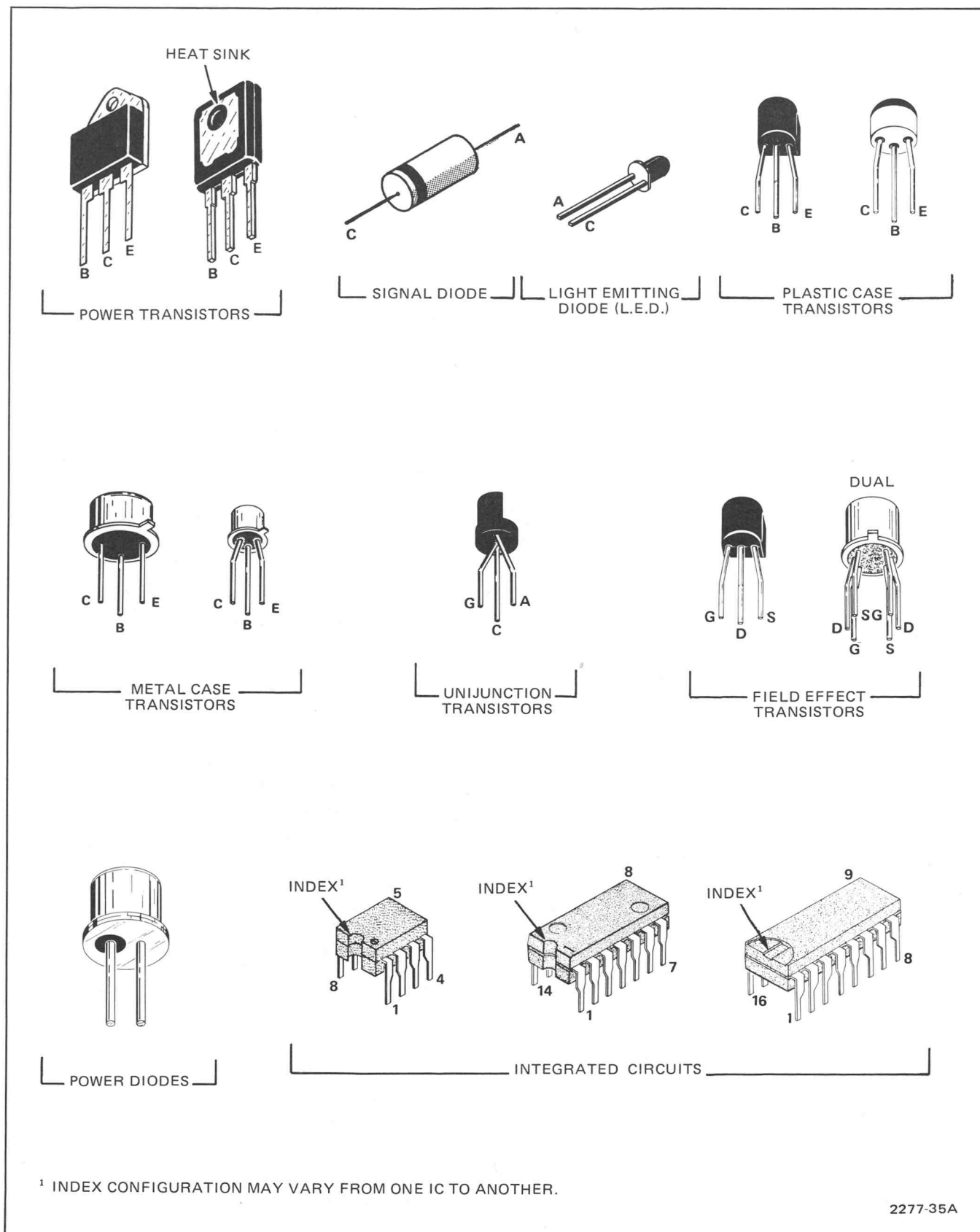


Figure 4-5. Semiconductor lead configurations.

TYPICAL POWER SUPPLY VOLTAGES

Table 4-2 lists the output voltages and typical ripple of the 413 power supplies. These voltages are measured between the power supply test points and ground (see Adjustment and Test Point Locations pullout page in Section 8, Diagrams and Circuit Board Illustrations).

TABLE 4-2
Power Supply Voltages

Power Supply Voltage	Test Point	Typical Voltage Range	Typical Ripple Peak-to-Peak
-12	TP2093	-11.9 to -12.1 V	100 mV
-7	TP2089	6.8 to -7.2 V	75 mV
+7	TP2083	+6.8 to +7.2 V	75 mV
+12	TP2077	+11.5 to +12.5 V	100 mV
-35	Emitter Q1674	-37 to -42 V	0.5 V
+35	Emitter Q1664	+37 to +42 V	0.5 V
-50 (HV BD)	Junction CR2163 C2163	-45 to -55 V	1.5 V
-90 (DVM BD)	TP1011	-85 to -95 V	1.3 V
+175 (HV BD)	Junction CR2161 C2161	+170 to +180 V	0.7 V
+5 (DVM BD)	TP1006	+4.95 to +5.05 V	30 mV
+75 (DVM BD)	TP1016	+70 to +80 V	2.5 V
+165 (DVM BD)	TP1013	+160 to +170 V	7.5 V
+3400	CRT ANODE	+3200 to +3600 V ¹	
0.6 V ac rms crt heater	Pin 1 of Crt socket	0.54 to 0.66 V ac	
+2.5 V Primary Ref.	TP1984	+2.45 to +2.55 V	
+5 V Secondary Ref.	TP1994	Calibrated to within 5 mV	

¹Reads approximately 3200 V \pm 200 V when measured with 20 k Ω /V VOM.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components and assemblies in the monitor are given here.

SERVICE RECORDS

It is advisable to keep a detailed service record, since the monitor and its accessories are involved with patient care and safety. Include information such as monitor type and serial number, failure, symptoms, routine maintenance performed, and the date.

READJUSTMENT AFTER REPAIR

After any electrical component has been replaced, check the adjustment of that particular circuit and other closely related circuits. Check the adjustment of the entire monitor after working on the power supply. ECG patient-circuit leakage must be checked following any repair or readjustment.

OBTAINING REPLACEMENT PARTS

STANDARD PARTS

All electrical and mechanical part replacements can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order from Tektronix, Inc. Before ordering or purchasing replacement parts, check the parts list for value, tolerance rating, and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be direct replacements unless you know that a different component will not adversely affect instrument performance.

SPECIAL PARTS

Some components in the monitor are manufactured or selected by Tektronix, Inc. to meet specific performance requirements. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

ORDERING PARTS

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

Disconnect the monitor from the power source, turn the monitor off and unplug the battery (P1982) before soldering.

Use ordinary 60/40 solder and a 15 watt pencil-type soldering iron for most soldering in this instrument. If higher wattage soldering irons are used to remove large surface components, be careful not to apply so much heat that the etched circuit wiring separates from the base material. Excessive heat can also cause serious damage to multi-layer circuit boards.

CAUTION

Several of the circuit boards in the 413 Monitor are multi-layer type boards with a conductive path laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to this center conductor. The following boards in the 413 Monitor are multi-layer: A2—Respiration, A3—Pressure/Pulse, A5—Conditioner, A6—Main.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

Disconnect the monitor from the power source and unplug the battery plug (P1982) before disassembling instrument and replacing components.

BATTERIES

Before replacing the batteries, read the Battery Operation and Condition information in the Operating Information section.

The battery pack consists of four F-size, 1.25 V nickel-cadmium (NiCd) cells, which are mounted inside of a metal case and fastened to the left side rail with two #4-40 flat-head screws. The battery power plug (P1982) is connected to the Main board.

CAUTION

The nickel-cadmium cells are capable of delivering a high current. Do not short circuit the cells, since this can cause the wire insulation to melt and the fuses to blow.

TO REMOVE BATTERIES:

1. Unplug battery pack plug (P1982) from the Main board.
2. Unplug recorder battery-power plug (P2130) if recorder is attached.
3. Remove four nuts holding battery pack together.

NOTE

Do not replace individual cells unless the batteries are relatively new (e.g., less than one year). Replace cells only with the type specified. Other types may not function properly or may be a hazard to the monitor and personnel. Operating time and/or high-temperature performance may be degraded.

BATTERY FUSE REPLACEMENT

To replace the battery fuses, first remove and disassemble battery pack. Then carefully unsolder and replace defective fuses that are mounted on small circuit board between the two center cells. Reassemble and reinstall battery pack.

PUSHBUTTONS

Remove pushbuttons by pulling them straight off the switch shafts or extensions using pliers protected with cloth or tape. Install pushbuttons by pressing them onto the switch shafts or extensions.

PUSHBUTTON-EXTENSION SHAFTS

To remove extension shafts, insert a sharp pointed tool (such as a scribe) between end of switch shaft and extension shaft. Moving the scribe back and forth will cause extension shaft to be released from the switch shaft. See Figure 4-6.

To install extension shaft, press it straight onto switch shaft until it snaps in place.

INTERCONNECTING CABLES AND TERMINAL CONNECTORS

Interconnecting cable assemblies used in the monitor consist of multiple-conductor cable with machine-installed terminal connectors, mounted in plastic holders.

The plastic holders, except on the battery cable, can be replaced easily. However, if the cable is defective, such as a wire broken loose from the terminal connector, it is often advisable to replace the complete cable assembly.

If the terminal connectors come loose from the plastic holder, they can be reinstalled as shown in Figure 4-7. When reinstalling connectors on board pins, be sure to match the triangle on the connector holder with the triangle on the circuit board for proper orientation.

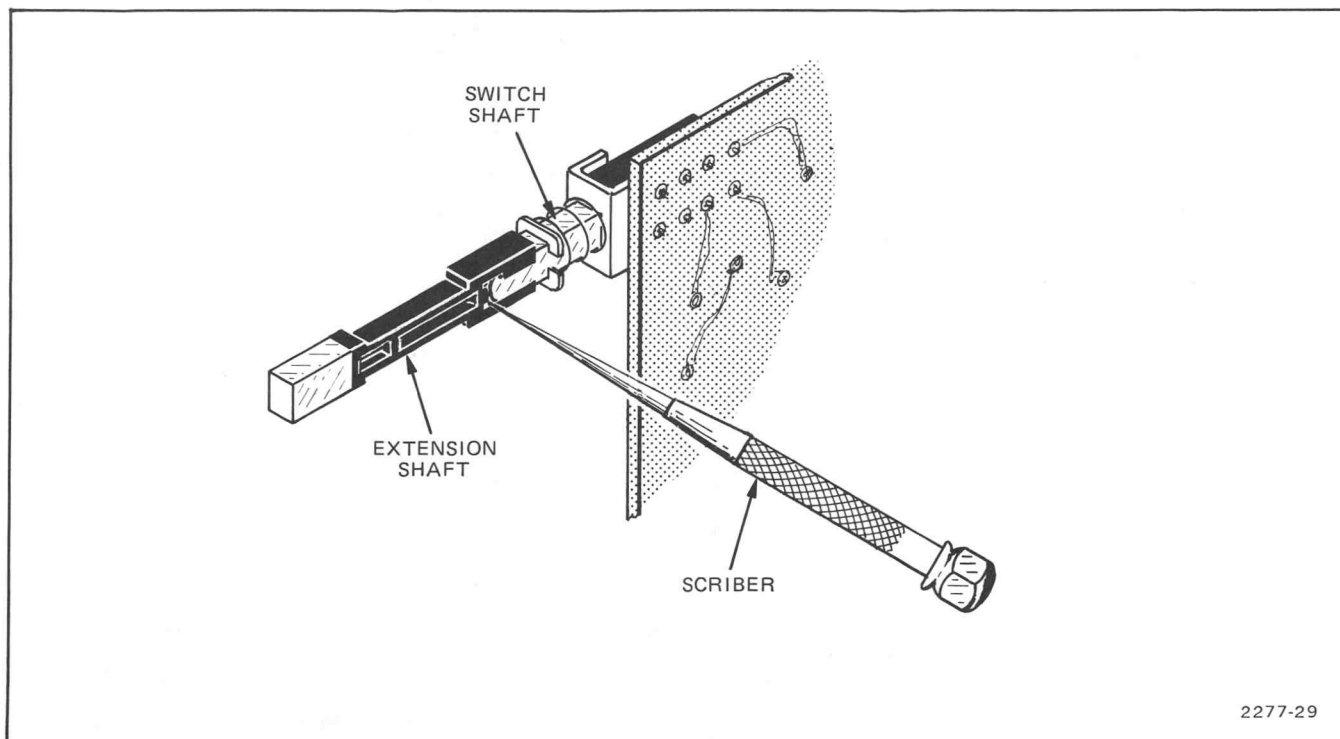


Figure 4-6. Removing pushbutton extension shaft.

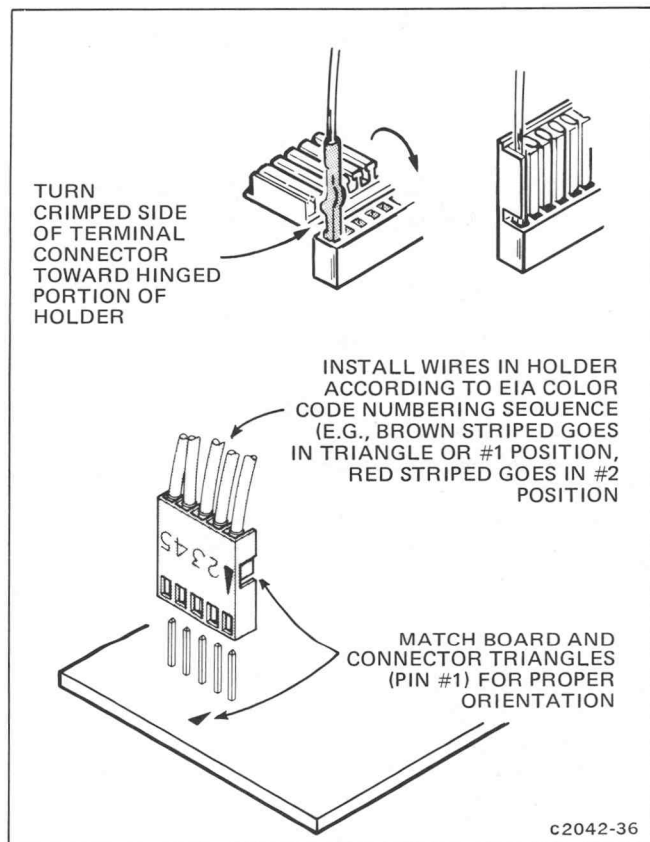


Figure 4-7. Installation and orientation of terminal connectors.

SEMICONDUCTORS

CAUTION

See semiconductor Caution page.

Semiconductors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the adjustment of this instrument. When semiconductors are replaced, check the operation of that part of the instrument which may be affected.

CAUTION

To avoid component damage, power must be turned off before removing or replacing semiconductors.

Replacement devices should be of the original type or a direct replacement. Figure 4-5 shows the lead configurations of the semiconductor devices used in this instrument. When replacing, check the manufacturer's basing diagram for correct basing. Semiconductors that have heat radiators use silicone grease to increase heat transfer. Replace silicone grease when replacing these semiconductors.



YOU ARE DESTRUCTIVE **STATIC DISCHARGE** CAN DAMAGE COMPONENTS



FACT: BOTH **MOS** AND **BIPOLAR** INTEGRATED CIRCUITS CAN BE DAMAGED BY DISCHARGE OF STATIC ELECTRICITY.

FACT: BOTH **DIGITAL** AND **LINEAR** I.C.'S CAN BE DAMAGED.

FACT: I.C.'S CAN BE DAMAGED WHEN THEY ARE **IN THE CIRCUIT** AS WELL AS WHEN THEY ARE NOT.

FACT: DAMAGE MAY **NOT** BE **APPARENT** FOR **SEVERAL MONTHS**.

RECOMMENDED HANDLING RULES

STORING AND TRANSPORTING

Don't remove semiconductors or boards containing semiconductors from original antistatic container until needed.

Don't place semiconductors or boards containing semiconductors on or in plastic containers, styrofoam or other nonconductive material. Use material specifically treated for antistatic qualities.

Do use grounded soldering iron and test equipment.

Do turn the instrument power off before removing or inserting semiconductors.

Do use a grounded conductive bench top when working on boards or instruments containing semiconductors. If not available, use uncoated cardboard as a substitute.

INSTALLING

Do discharge static charge from your body. Connect yourself to ground through 100 k Ω while handling circuits or semiconductors.

Don't slide semiconductors or boards containing semiconductors across any surface.

Don't touch semiconductor leads unless necessary.

WARNING

Handle silicone grease with care. Avoid getting the silicone grease in your eyes. Wash hands thoroughly after use.

An extracting tool should be used to remove integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix part 003-0619-00. If an extracting tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. To prevent damage to the pins avoid having one end of the integrated circuit disengage from the socket before the other.

INTERCONNECTING CIRCUIT-BOARD PINS

A circuit-board pin replacement kit, including necessary tools, instructions, and replacement pins with attached spare ferrules, is available from Tektronix, Inc. Order Tektronix Part 040-0542-00. Replacement of circuit-board pins on multi-layer boards is not recommended; refer such repairs to your local Tektronix Field Office or representative.

CAUTION

*Replace circuit-board pins on multi-layer boards with extreme caution. See **Soldering Techniques for identification of multi-layer boards in this instrument.***

To replace a damaged pin, first disconnect any pin connectors. Then unsolder the damaged pin (see **Soldering Techniques**) and pull it out from the board with a pair of pliers, leaving the ferrule (Figure 4-8) in the hole if possible. If the ferrule remains in the circuit board, remove the spare ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the ferrule is removed with the damaged pin, clean out the hole using a solder-removing tool and a scribe. Then press the replacement pin, with attached spare ferrule, into the hole. Position the replacement pin in the same manner as the original pin had been. Solder the pin to the circuit board on each side of the circuit board. If the original pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

FRONT PANEL

To remove front panel:

1. Remove amber plastic filter and black metal mask from readout housing. Use small-bladed screwdriver or small utility knife and carefully pry filter and mask out of readout housing.

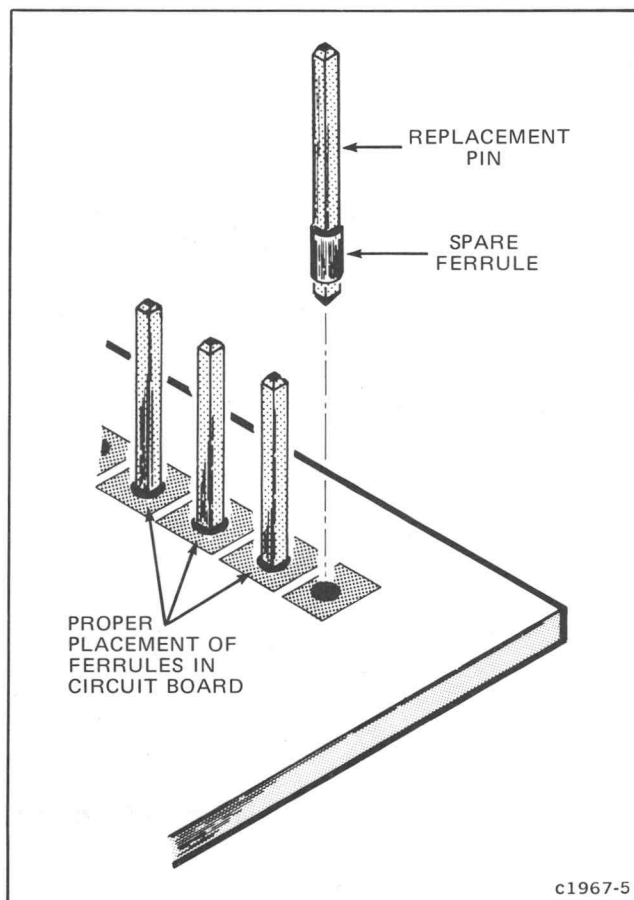


Figure 4-8. View of typical circuit-board pin and ferrule.

2. Remove two screws holding readout housing to front panel. Remove housing.
3. Remove crt bezel and graticule (held with four screws).
4. Remove six knobs using 1/16 inch hex allen wrench.
5. Remove nuts and flat washers from the six potentiometers.
6. Pull front panel away from front subpanel.

To install front panel reverse the above procedure while observing the following precautions:

1. When replacing black metal mask make sure bumps on inside of mask opening are just above the HEART and TEMPERATURE A pushbuttons; if not turn mask over.
2. Place concave side of amber filter toward readout devices; in this direction the readout elements are less visible.

3. Be sure to check alignment of knob indexes with front panel numbers. If unsure about where to align knob index marks, rotate the control from one extreme to the other and adjust knob on shaft so that index stops the same distance from the center bottom at each extreme. Check calibration of ECG, pulse, and rate limits functions with regard to front-panel knob settings.

FRONT ASSEMBLY

The front assembly can be removed as a single unit from the main instrument frame to replace components or make repairs.

To remove front assembly:

1. Carefully discharge crt-anode connector to chassis.
2. Disconnect crt-anode connector. See Figure 4-9.
3. Remove RESPIRATION SIZE knob, nut, and flat washer.
4. Remove four nuts, one at each inside corner of front frame casting.
5. Unplug crt base plug from HV board and yoke plug from Main board.

6. Disconnect all plugs along front edge of Main board and Conditioner board, except black two-wire speaker plug at crt end of Mainboard.
7. Carefully pull the front panel away from the main frame casting.

To install front assembly:

1. Guide cables into front casting opening and set front assembly in place. Make sure cables are emerging toward the bottom of the instrument and do not get caught on the top of the Main board.
2. Set front assembly in place in front casting, guiding pushbuttons into the appropriate holes in the front panel.
3. Secure assembly with the four #4 nuts.
4. Mount RESPIRATION SIZE control with flat washer and nut. Install knob.
5. Connect crt-anode connector.
6. Connect crt base and yoke plugs (P2141 & P1690).
7. Connect cable plugs to Main board and Conditioner board as shown in Figure 4-10.

CIRCUIT BOARDS

Occasionally a circuit board may be damaged beyond repair. If this is the case, replace the entire board assembly. Part numbers for completely wired boards are given in the Replaceable Electrical Parts list. Circuit board locations are shown in Figure 4-14.

CAUTION

To prevent instrument damage when installing boards, be sure to properly align interconnecting pins and plastic guide pins on Main board with receptacles on plug-in boards.

ECG Board

To remove board:

1. Remove board retainer clip (Figure 4-2).
2. Remove screw holding board to right-hand rail. See Figure 4-1.
3. Pull board straight away from Main board to unplug.
4. Tip board as necessary and remove from instrument.

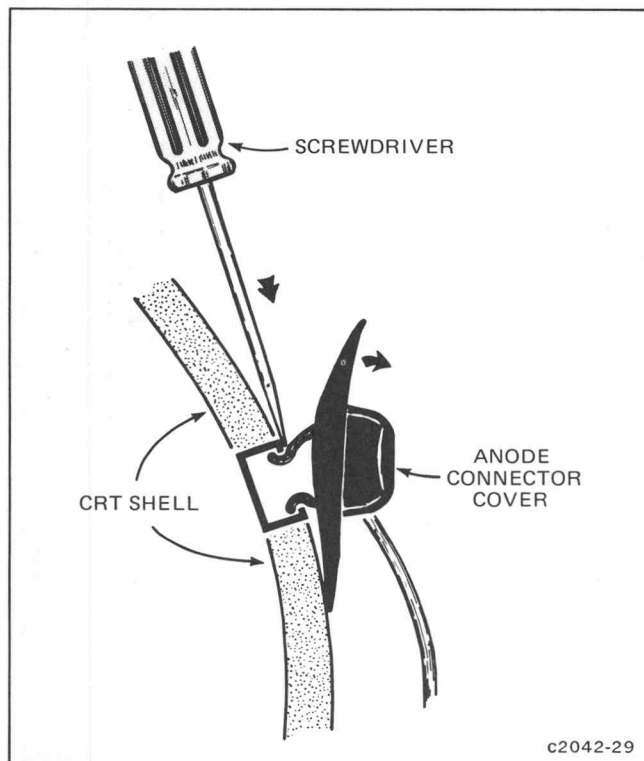


Fig. 4-9. Crt-anode connector removal and installation.

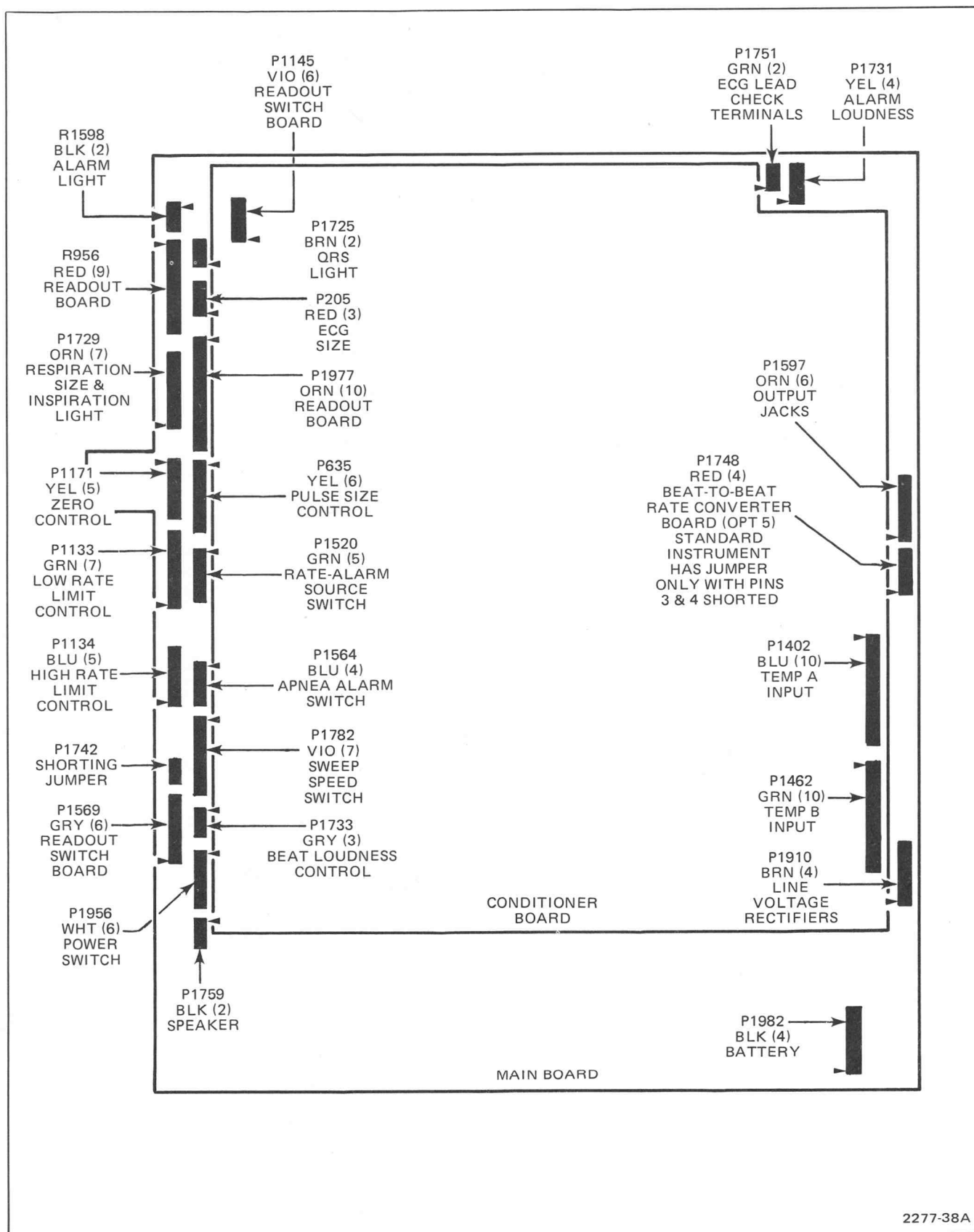
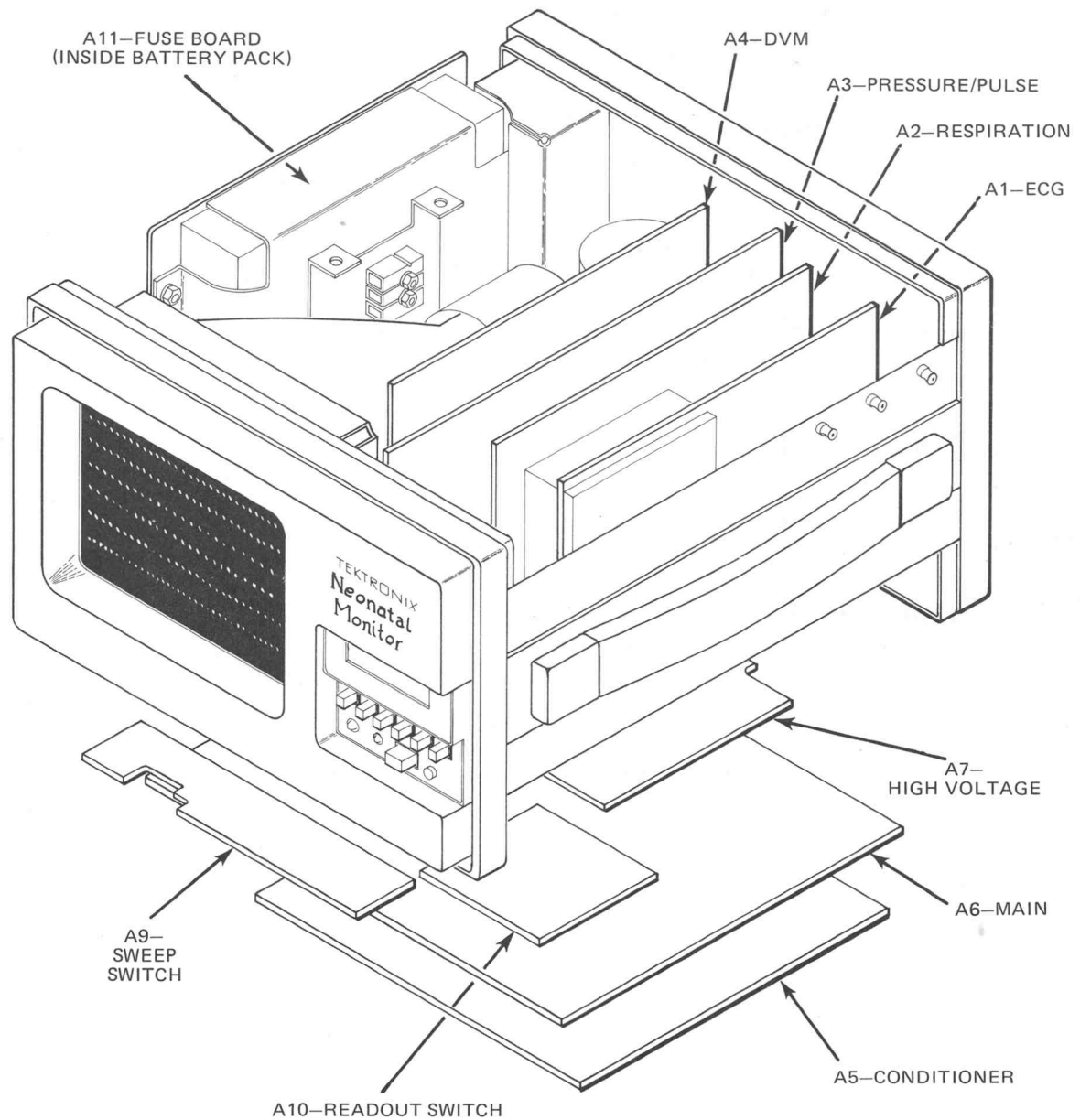


Figure 4-10. Main and Conditioner board cable connections.



2277-17

Figure 4-11. Circuit board locations.

5. Unplug P462 (3-conductor plug) from Respiration board.
6. Remove screw from input circuit shield. Slide shield down cables.
7. Unplug both cable plugs from board.

To install board:

1. Connect ECG input cable plug (P131) and respiration input cable plug (P162) to board. Be sure to match triangles on plugs with those on board.
2. Install shield as shown in Figure 4-12.
3. Connect respiration input plug (P462) to Respiration board.
4. Plug ECG board onto interface pins on Main board. Tip board and insert pushbuttons into holes in front panel before plugging board onto interface pins.
5. Install board retaining screw through side rail. See Figure 4-1.
6. Dress all cables away from circuit board shield, ECG input connector shield, and switch shafts.

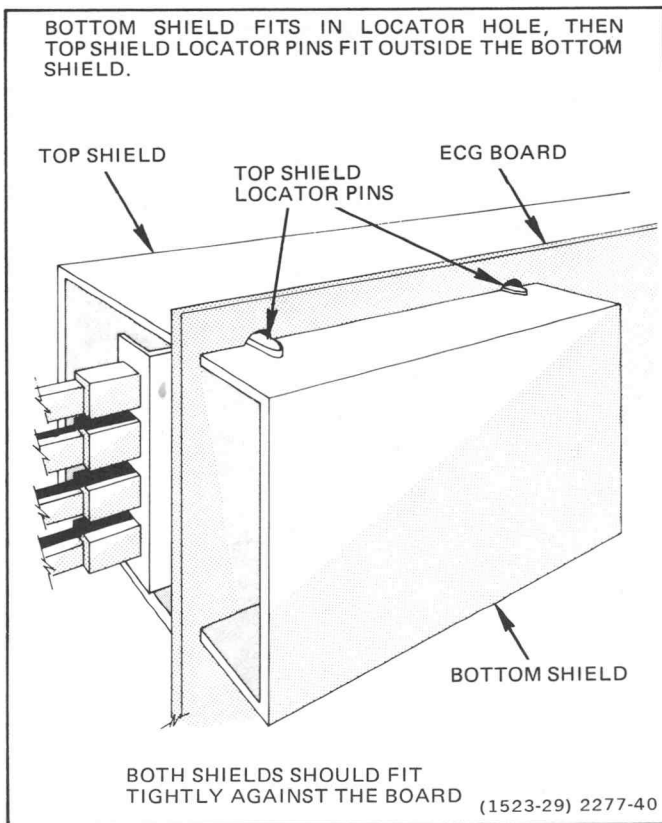


Figure 4-12. ECG shield installation.

7. Install board retainer clip. See Figure 4-2.
8. Check calibration of ECG channel and check ECG patient-circuit leakage. Refer to Calibration section.

RESPIRATION BOARD

To remove board:

1. Remove extension shaft from Respiration DISPLAY OFF switch shaft. See Figure 4-6.
2. Pull Respiration board straight up to unplug from Main board.
3. Unplug respiration input cable plug (P462).

To install board, reverse procedure.

PRESSURE/PULSE BOARD

To remove board:

1. Unplug 2 cable plugs from rear of boards.
2. Pull board straight up to unplug. Lift rear of board higher than front to release front plastic guide pin.
3. Remove board from instrument.

To install board:

1. Set board in place over interface pins without inserting pushbuttons through front panel.
2. Lift rear of board and insert pushbuttons into their respective holes in the front panel.
3. Lift up on front of board and align plastic guide pin on Main board with guide on Pressure/Pulse board. Align rear guide and pin and plug board onto interface pins.
4. Connect cable plugs to rear of board. The 6-conductor brown plug goes to the outside pins and the red plug goes to the inside pins.

DVM BOARD

Pull board straight up to unplug.

To install board, position board assembly so that the metal shield is facing the Pressure/Pulse board, align plastic guides, and plug board onto interface pins. Make sure support pin on crt bracket fits between board and metal shield.

CONDITIONER BOARD

To remove board:

1. Unplug 3 cables from board.

2. Remove 3 screws holding Conditioner board to Main board.
3. Unplug 60-pin interface connector (P1100). Use a small screwdriver and pry between side rail and edge of board. Pry a little at a time along the length of connector until the pins are released from the plug.

To install board:

1. Set insulating sheet in place over Main board components.
2. Align Conditioner board interface pins with sockets on Main board.
3. Press along length of connector a little at a time until all pins are seated firmly into their sockets.
4. Connect 3 cables to Conditioner board: P1145, violet, 6-conductor plug; P1402, blue, 10-conductor plug; P1462, green, 10-conductor plug.

MAIN BOARD

To remove board:

1. Remove ECG, Respiration, Pressure/Pulse, and DVM boards.
2. Unplug crt base cable plug (P2141) and yoke plug (P1690).
3. Carefully discharge anode connector to chassis.
4. Disconnect crt-anode lead. See Figure 4-9.
5. Remove Conditioner board.
6. Unplug all cable plugs from Main board.
7. Remove front assembly.
8. Remove 11 screws holding Main board brackets to side rails and rear panel.
9. Main board can now be removed from monitor.

To install board, reverse removal procedure. Refer to Figure 4-10 for locations of cable plugs.

HIGH-VOLTAGE (HV) BOARD

To remove board:

1. Remove battery pack.
2. Remove DVM board.

3. Remove front assembly. Refer to instructions given previously.

4. Remove screws holding Conditioner board. Unplug Conditioner board from Main board and move it aside to gain access to two HV board mounting screws. It is not necessary to unplug cable plugs from Conditioner board.

5. Remove two screws holding the HV board to the Main board.

6. Unplug HV board from Main board. Remove board and insulating card from instrument taking care not to bend pins on the Main board.

To install board:

1. Lay insulating card on Main board between HV board pins. Align hole in insulating card over hole in Main board nearest front of monitor.
2. Set HV board in place over pins on Main board. Carefully align pins and sockets and press HV board against Main board.
3. Secure HV board with two screws through Main board. Position insulating card as necessary to install the front screw.

4. Install Conditioner board.

5. Install front assembly.

6. Install DVM board.

DISPLAY BOARD

To remove board:

1. Remove ECG board and Respiration board.
2. Unplug 2 interconnecting cables from Display board.
3. Remove 2 mounting screws.

To remove display devices from Display board:

Using a screwdriver (preferably with plastic shaft), carefully pry readout device out of its socket. Pry a little at each side until readout device is released from socket. Make sure pins are straight before attempting to install readout device.

To install board, reverse removal procedure. Then check ECG and Respiration adjustments and check ECG patient-circuit leakage. See Calibration section.

READOUT SWITCH BOARD

To remove this board, it is necessary to remove the ECG and Respiration board, the front panel, and the two screws through the front subpanel.

After replacing Readout Switch board, check those adjustments related to replacement of the ECG and Respiration board.

SWEEP SWITCH BOARD

To remove this board, it is necessary to remove the front panel and the two screws through the front subpanel.

ALARM LIGHT

The ALARM light assembly is sandwiched between the readout housing and the nomenclature decal surrounding the readout pushbuttons.

To remove the decal, carefully pry around the edges with a knife. To install decal: set it in place over readout pushbuttons and press down firmly. Use a blunt, smooth instrument to prevent scratching decal.

ZERO CONTROL

To remove ZERO control:

1. Remove DVM board and Pressure/Pulse board.

2. Remove front panel.

3. Pull ZERO knob off.

4. Remove mounting nut (recessed in subpanel).

5. Remove four nuts (one at each inside corner) holding front assembly.

6. Pull front assembly away from front frame casting just far enough to remove the screw holding the cable clamp to lower right corner of crt retainer.

To install ZERO control, reverse removal procedure.

QRS AND INSPIRATION LED

To replace either QRS or INSPIRATION LED (light-emitting diode), proceed as follows: Refer to Figure 4-13.

1. Remove LED holder cap by pulling it off holder.

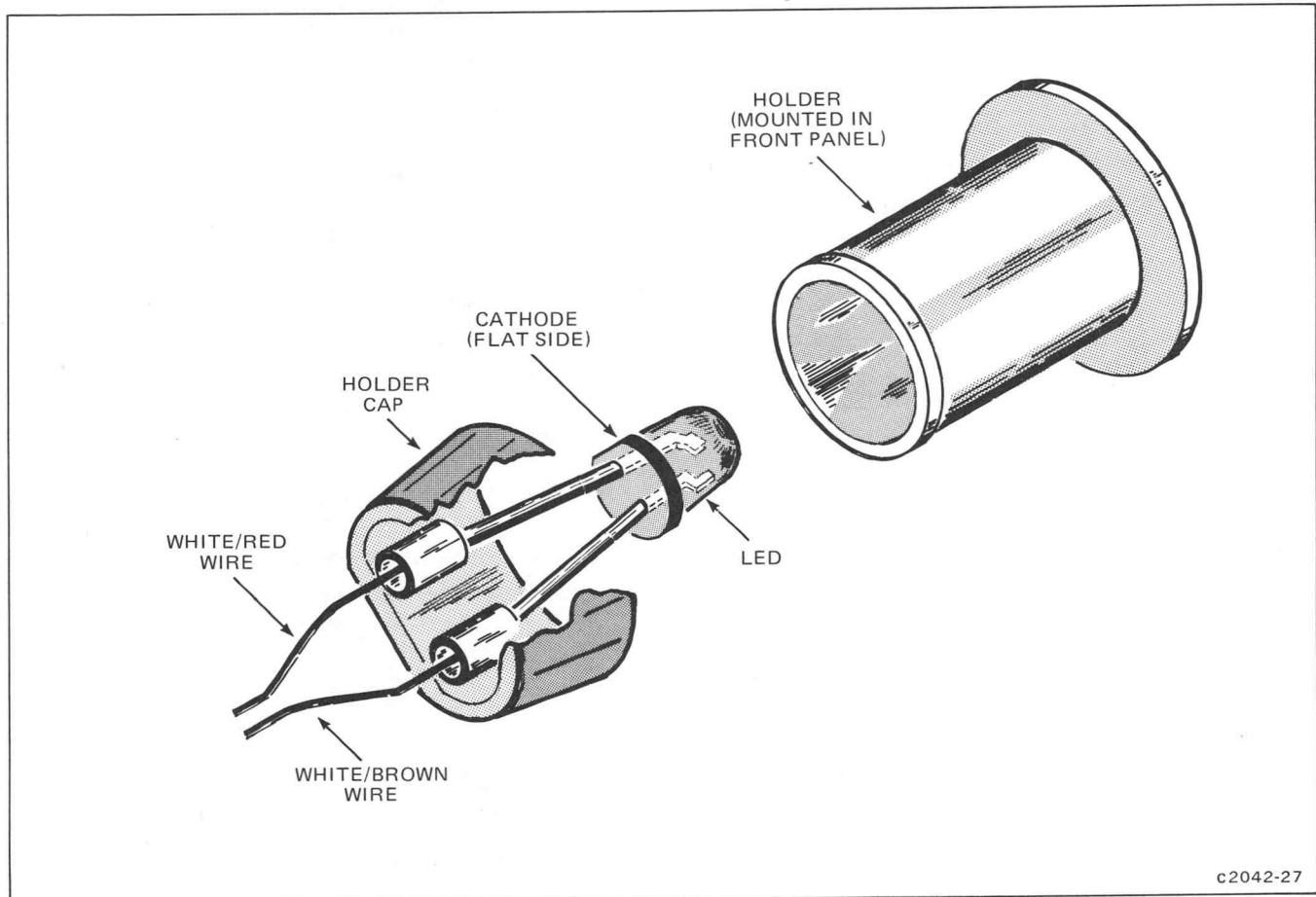


Figure 4-13. QRS and INSPIRATION LED replacement.

2. Unsolder and remove LED from holder cap. See Caution below.

CAUTION

The holder cap melts easily with excessive heat. Use soldering iron of 15 watts or less.

3. Trim leads on new LED to same length as on one removed.
4. Solder new LED to holder cap, observing Caution given above. Note correct orientation of cathode lead.
5. Snap holder cap and LED assembly onto holder.

CRT

To replace the crt, proceed as follows:

WARNING

Handle the crt carefully. Rough handling or scratching increases the implosion hazard.

To remove the crt:

1. Remove front assembly. Refer to instructions given previously.
2. Remove four #4 screws holding crt retainer frame to front subpanel.
3. Pull crt and retainer away from front subpanel and remove from the instrument.

To install crt:

1. Set crt and retainer in place against front subpanel. Make sure plastic corner pads are in place and ears on crt retainer frame are set into slots in front subpanel.
2. Secure crt retainer frame with four #4 screws. The shorter screw and spacer go to the upper right corner.
3. Set front-panel assembly in place and secure with four #4-40 nuts. Be careful not to pinch cable wire between subpanel and front frame casting.
4. Install front assembly.
5. After replacing crt, check following adjustments (see Calibration section): Centering Rings, CRT Yoke, Focus (R2140), Horizontal Position (R1835), Horizontal Width (R1845), Trace Zero (R690), and Vertical Sensitivity (R1685).

ACCESSORY REPAIR

The following information should be considered when replacing or repairing accessories.

PRESSURE TRANSDUCERS

Pressure transducers are not considered field repairable. Repair or replacement should be done by the transducer manufacturer.

All non-differential transducers have a vent tube to atmospheric pressure. In many cases, this vent tube is within the transducer cable. Do not crush or kink this cable, because doing so could close the tube and prevent calibrated operation.

Transducer cable end-connectors frequently contain selected components and are often sealed with potting compound or epoxy, so that repair is difficult or impossible. Factory replacement of connectors by the transducer manufacturer may be the only practical alternative; the original selected components may not be reusable and the factory is best equipped to reselect components.

ECG CABLES

ECG cables are not considered repairable.

Snap connectors should grip the electrode terminal firmly. If not, they often can be tightened by bending the contact inward gently with a scribe or small screwdriver.

CALIBRATION

INTRODUCTION

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

ECG LEAKAGE CHECK

ECG patient-circuit leakage must be checked following any repair or adjustment. Also, it is advisable to check leakage any time the monitor has been dropped or otherwise abused. A leakage check procedure is located at the end of the Check/Adjust Procedure and in Section 4, Maintenance.

ADJUSTMENT INTERVAL

Monitor performance should be checked and adjustments made at least every 1000 hours, or 6 months if used infrequently. Partial or complete readjustment should be performed following specific repairs; see Section 4, Maintenance.

TEST EQUIPMENT REQUIRED

The test equipment and accessories listed in Table 5-2 are required for complete adjustment of the 413 Monitor. The specifications given for the test equipment are the

minimum necessary for accurate adjustment. All test equipment should be correctly calibrated and operating within their specifications.

SPECIAL TEST ACCESSORIES

The special test accessories required for adjustment can be readily constructed using common electronic components. Be sure to use components with at least the accuracy specified.

PARTIAL ADJUSTMENT

Partial adjustment is often desirable after replacing components or just to touch up the adjustment of a portion of the monitor between major performance checks.

Many adjustments can be made independently without affecting the adjustment of other portions of the monitor. However, if the +5 volt adjustment is changed, it will be necessary to check the performance of the entire monitor. Refer to Table 5-1 to determine which adjustments should be made when replacing circuit board assemblies and the cathode-ray tube (crt).

TABLE 5-1

Adjustments Needed After Assembly Replacement

<div><div>IF THESE ASSEMBLIES ARE REPLACED</div><div>THESE ADJUSTMENTS MUST BE CHECKED OR ADJUSTED</div></div>		A. POWER SUPPLY & DISPLAY																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
		+5 V—R1990	Focus—R2140	Horiz Position—R1835	Horiz Width—R1845	Clock—R1610	Crt Centering Rings	Trace Alignment—Yoke	B. ECG			C. RESPIRATION			D. Digital Display		E. TEMPERATURE						F. PRESSURE/PULSE			G. RATE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
MAIN BOARD	ECG BOARD	RESPIRATION BOARD	PRESSURE/PULSE BOARD	CONDITIONER BOARD	DVM BOARD	DISPLAY BOARD	CATHODE-RAY TUBE (CRT)	HIGH VOLTAGE BOARD																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

FUNCTIONAL CHECK ONLY

TABLE 5-2
Test Equipment

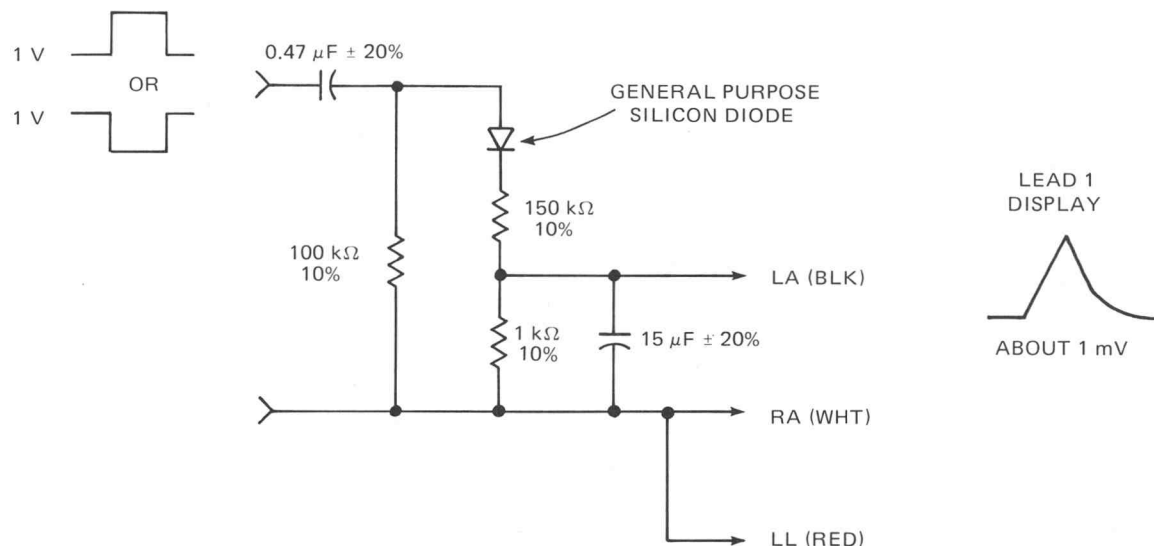
Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
1. Function generator	Output Amplitude, 1 V square wave; Risetime 10 μ s or faster; Frequency Range, 0.5 Hz to 10 Hz.	Horiz Width, ECG Gain and Rate Cal adjustments. Pacer Signal Rejection and ECG output checks. Respiration Rate.	TEKTRONIX FG501 Function Generator. ¹
2. Test oscilloscope	Bandwidth, dc to at least 500 kHz; Minimum Vertical Deflection Factor, 1 mV/div; Sweep Rates, 10 μ s/div to 200 ms/division.	2 kHz Clock Adjustment ECG Gain and Input Offset Null adjustments, QRS Timing, QRS Width, Rate Alarms, and insulation checks. Respiration Null & Balance.	Any TEKTRONIX Oscilloscope. ²
3. Universal counter	Measures periods and pulse length; Range is to 800 μ s; Accuracy, within 1%.	Function generator frequency verification.	TEKTRONIX DC503 Universal Counter. ¹
4. Digital voltmeter (test DVM)	Accuracy, within 0.1%.	+5 volt, DVM Zero, DVM Cal, and Temp Span adjustments. Pressure/Pulse output checks.	TEKTRONIX DM501 Digital Multi-meter. ¹
5. Manometer	Range, 0 to 250 mmHg; Accuracy, within 1%.	Pressure checks and adjustments.	
6. Pressure transducer	Standardized to 50 μ V/V/cmHg.	Pressure checks and adjustments.	
7. Pulse sensor		Pulse checks.	TEKTRONIX Pulse Sensors: 015-0236-01 (finger), 015-0237-01 (radial).
8. Low-pass filter and attenuator	Fig. 5-1A.	Horiz Width, ECG Gain, and Rate Cal adjustments. ECG output checks.	
9. ECG shorting connector	Fig. 5-1B.	Input Offset Null and DC Level adjustments.	
10. Stereo phone plug	Fig. 5-1C.	DC Level and ECG Gain adjustments. Pressure/Pulse output checks. Respiration Checks & Adjustments.	
11. Precision attenuator	Fig. 5-2A.	ECG Gain check.	
12. CMRR-leakage test fixture	Fig. 5-2B.	CMRR and Leakage checks.	
13. Pacer input circuit adapter	Fig. 5-2C.	Pacer Signal Rejection Checks.	
14. Temperature sensor substitution plugs	Fig. 5-3.	DVM Cal and °F/°C Cal adjustments.	
15. Respiration test fixture	Fig. 5-4.	Respiration Adjustments.	
16. Leakage test fixture	Fig. 5-5.	Leakage checks.	
17. Patient cable		Respiration adjustments	Use TEKTRONIX Part 012-0739-00 only.

¹Requires TM500 Power Module.

²Tektronix 200 Series Oscilloscope is recommended for isolation checks.

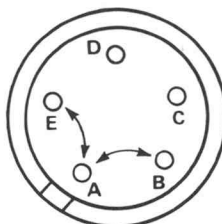
A. LOW-PASS FILTER AND ATTENUATOR

THE VALUES WERE SELECTED TO DETERIORATE PULSE RISETIME, PERMITTING THE QRS DETECTOR AND TRIGGER TO FUNCTION AND TO PROVIDE A SINGLE POSITIVE PULSE DISPLAY FOR EACH SQUARE WAVE.



B. ECG SHORTING CONNECTOR

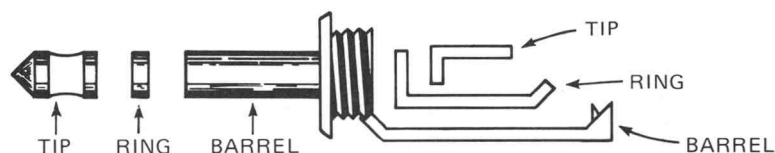
MS3102A-14S-5P
BACK OF PLUG



CONNECT A, B, AND E
TOGETHER

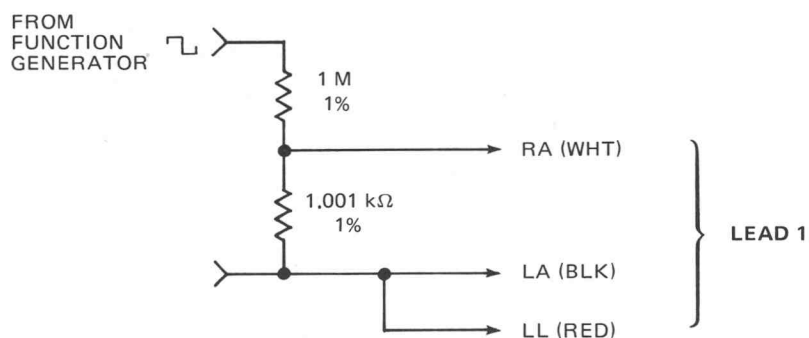
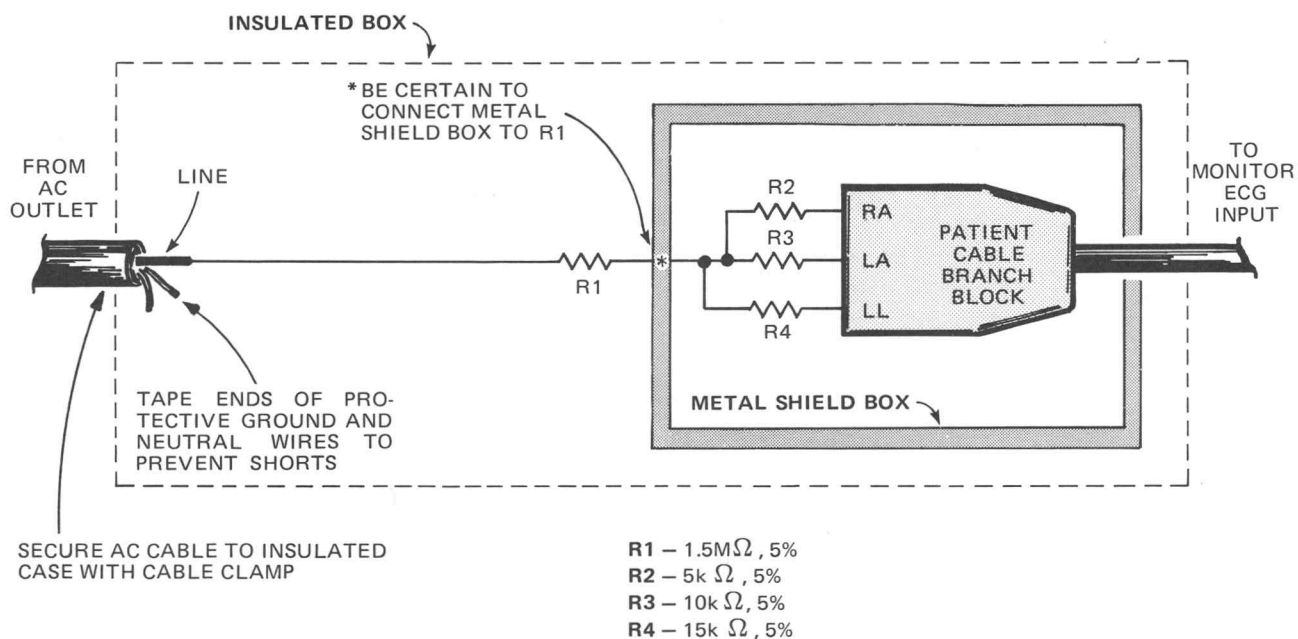
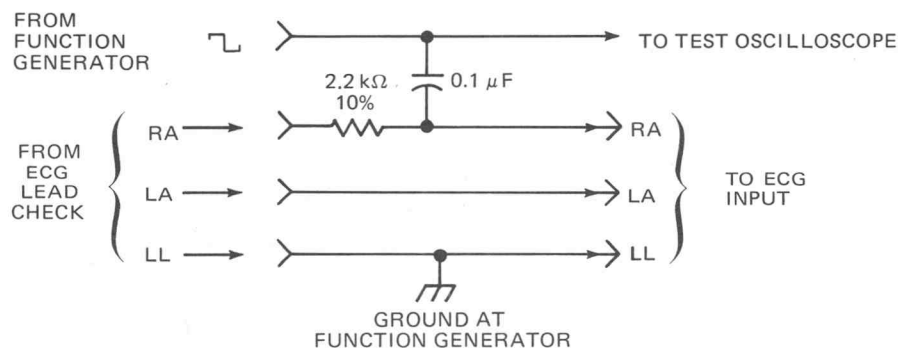
C. STEREO PHONE PLUG

A STEREO PHONE PLUG WITH ITS COVER REMOVED MAKES A CONVENIENT TEST POINT FOR OBTAINING OUTPUT SIGNAL.



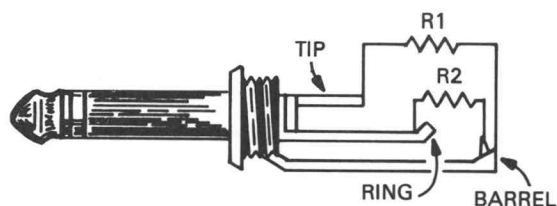
c2042-1

Fig. 5-1. Wiring details for the low-pass filter and attenuator, ECG shorting connector, and stereo phone plug test fixtures.

A. PRECISION ATTENUATOR**B. CMRR-LEAKAGE TEST FIXTURE****C. PACER INPUT CIRCUIT ADAPTER**

2042-2B

Fig. 5-2. Wiring details for the precision attenuator, pacer input circuit adapter, and CMRR-leakage test fixtures.



°F	°C	R1(Ω)	TEKTRONIX Part Number	R2(Ω)	TEKTRONIX Part Number
23	-5	25.40 K	321-1690-07	122.1 K	321-1692-07
41	5	15.24 K	321-1688-07	74.44 K	321-1691-07
77	25	6000	321-1696-07	30.00 K	321-0685-07
113	45	2620	321-1694-07	13.28 K	321-1687-07
98.6	37	3610	NONE	18.21 K	NONE

NOTES:

1. RESISTORS USED FOR THESE PLUGS SHOULD HAVE VALUES WITHIN 0.1% AND HAVE LOW TEMPERATURE COEFFICIENTS.
2. ANY SERIES OR PARALLEL COMBINATION OF QUALITY RESISTORS CAN BE USED TO PRODUCE VALUES OF R1 AND R2.
3. 98.6°F/37°C IS NOT NEEDED FOR ADJUSTMENT PROCEDURE; IT IS GIVEN FOR REFERENCE ONLY.
4. 23°F/-5°C RANGE CHECKED IN 400 RECORDER ONLY.

2042-101

Figure 5-3. Temperature sensor substitution plugs.

ADJUSTMENT PROCEDURES

There are two procedures in this section; a Check/Adjust Procedure and an Abridged Adjustment Procedure. The Check/Adjust Procedure is intended for complete monitor calibration. The Abridged Adjustment Procedure is intended to permit rapid touch-up of all internal controls.

PRELIMINARY CONSIDERATION

EARTH'S MAGNETIC FIELD

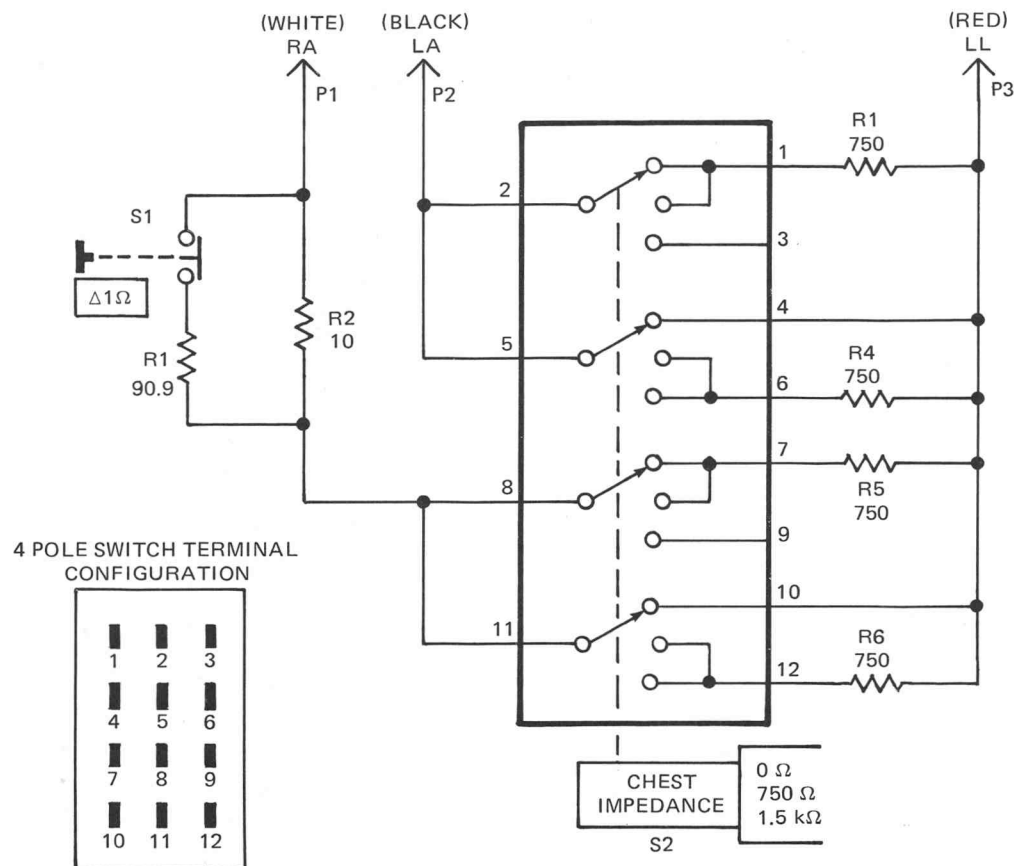
Vertical and horizontal trace positioning can be affected slightly by the position of the monitor in relation to the earth's magnetic field. Unless the monitor is kept in the normal viewing position when adjusting the spot centering and horizontal positioning, it may not be possible to match the user's display precisely.

WARNING

High voltage and high battery current capabilities exist inside the monitor. Voltages of over 15 volts are low-current sources and are not considered dangerous, but could produce an electrical shock. All ac line-voltage connections are covered and located on the rear panel.

DISASSEMBLY FOR ADJUSTMENT

Remove the four screws from each side. Pull the bottom cover straight away from the monitor. Lift the left side of top cover to permit the right side to clear the ECG LEAD CHECK terminals.



		SUGGESTED TEKTRONIX PART NO.
P1, P2, P3	FEED THRU TERMINAL (FOR ELECTRODE WIRE SNAP CONNECTORS)	(3) 131-1371-00
	BUSHING, INSULATOR (ATTACHING PARTS FOR TERMINALS)	(3) 358-0176-00
R2	RESISTOR MF 10 Ω, 1%, 1/4 W	321-0001-00
R1	RESISTOR 90.9 Ω, 1%, 1/4 W	321-0093-00
R3, R4, R5, R6	RESISTOR MF 750 Ω, 1%, 1/4 W	(4) 321-0181-00
S1	SWITCH, SP, MOMENTARY NORMALLY CLOSED	260-1285-00
S2	SWITCH, 4 POLE	260-1447-00

2277-14

Figure 5-4. Respiration test fixture.

CHECK/ADJUST PROCEDURE

PURPOSE

The purpose of this procedure is to permit the complete calibration of an operating monitor; it is not intended as a trouble-shooting guide. The procedure is divided by major functions to make it easier to adjust individual portions of the monitor.

Some monitor specifications are not verified by this procedure. Additional information can be found in section 1. General or on the schematics.

PRELIMINARY SETUP

POWER	In (on)
DISPLAY OFF (Resp).....	In (off)
DISPLAY OFF	
(Press/Pulse).....	In (off)
OFF (ECG)	In (off)
LOW RATE LIMIT.....	RATE ALARM
	OFF (ccw)
SWEEP SPEED	
mm/SEC 100	In
BEAT LOUDNESS.....	Midrange

Set the remaining controls as desired. Connect the monitor to the correct ac-line source. **DO NOT PRESET INTERNAL CONTROLS.** Allow monitor to warmup for about 20 minutes before making adjustments.

OPERATING TEMPERATURE

The monitor should be adjusted at an ambient temperature of +20° to +30°C for best overall accuracy.

PRELIMINARY CHECK

Check operation of all modes and correct any defects before attempting to adjust the monitor.

MAIN BOARD ADJUSTMENTS

To gain access to Mainboard adjustments, remove Conditioner board and add extender board and cables (from Servicing Extender Set, Tektronix Part 020-0291-00) to P1100, P1145, P1402, and P1462.

A. POWER SUPPLY AND CRT DISPLAY

Equipment Required

- | | |
|---------------------------------|--------------------------------|
| 1. Digital voltmeter (test DVM) | 3. Low-pass filter (Fig. 5-1A) |
| 2. Function generator | 4. Test oscilloscope |

BEFORE YOU BEGIN, see

TEST POINT AND
ADJUSTMENT LOCATIONS

in the Diagrams section.

A1. +5 VOLTS

a. Connect test DVM leads to Main board between ground (ground lug inside of rear panel) and +5 V (TP1994 Main board).

b. **CHECK**—Supply voltage should be +5 V, within 25 mV.

NOTE

Do not readjust +5 V supply if it is within 25 mV unless a complete recalibration is intended.

c. **ADJUST**—+5 V (R1990, Main board) for +5 V at TP1994.

d. Remove test DVM leads.

A2. CLOCK

a. Connect test oscilloscope input to TP1623, on Main board. Display 2 kHz square wave.

b. **CHECK**—Period of square-wave signal at TP1623 is 500 μ s.

c. **ADJUST**—Clock (R1610) so that square-wave period is 500 μ s.

A3. TRACE ROTATION

a. **CHECK**—Trace should be parallel with graticule lines.

b. Loosen yoke clamp (Fig. 5-5).

c. **ROTATE**—Yoke for non-tilted trace. Keep yoke forward as far as possible.

d. Tighten yoke clamp.

e. Recheck trace to ensure yoke was not moved when yoke clamp was tightened.

NOTE

Due to effects of earth's magnetic field, monitor should be positioned upright when performing steps A4, A5, and A6. Monitor will have to be supported above bench to make adjustments.

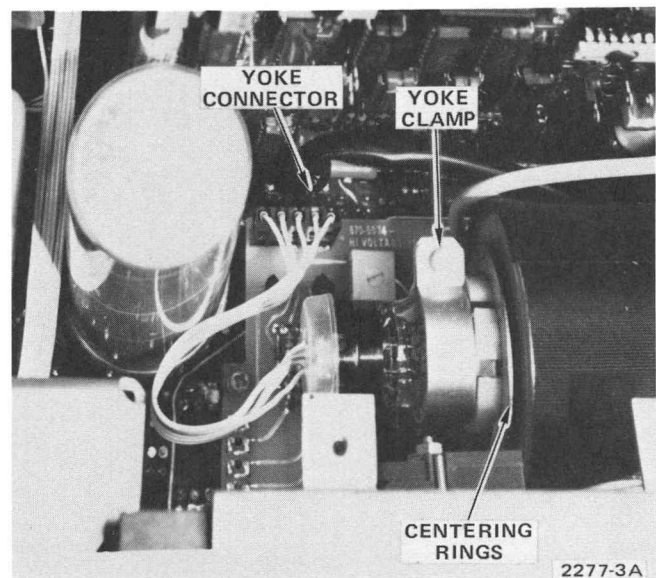


Figure 5-5. Yoke clamp, yoke connector (P1690), and centering rings.

WARNING

To avoid electric shock, be careful when making yoke adjustments. There is + and -35 V at the yoke, +175 V in the crt socket and +3400 V on the crt anode.

A4. SPOT CENTERING AND FOCUS

a. Set POWER button out (off) and disconnect yoke plug, P1690 (Fig 5-6). Set POWER button in (on).

b. **CHECK**—Spot should be centered on the graticule, within (approximately) 2 mm. Graticule center is at intersection of 75 mmHg line and straight edge centered diagonally across graticule.

c. **ADJUST**—Centering Rings for centered spot. Refer to Figure 5-6.

d. **CHECK**—Spot should be finely focused.

e. **ADJUST**—Focus (R2140, High-Voltage board) for smallest possible round spot.

f. Set POWER button out (off) and reconnect yoke plug. Be sure to match arrow on Main board. Set POWER button in (on).

A5. HORIZONTAL POSITION

a. **CHECK**—Trace should start at left end of graticule lines, within 2 mm.

b. **ADJUST**—Horiz Position (R1835, Main board)) so that trace starts at left end of graticule lines.

A6. HORIZONTAL WIDTH

a. Set:

ECG IIn
SWEEP SPEED
mm/SEC 50In

b. Connect function generator square wave through low-pass filter (Fig. 5-1A) to ECG INPUT connector. Set generator to display approximately 4 cm at 3 Hz (verify with universal counter). Monitor should produce beat tone and triggered display. Turn up BEAT LOUDNESS control if necessary.

c. **CHECK**—Fourth pulse leading edge should coincide with 60 BEATS/MIN mark, within 2 mm (see Fig. 5-6A).

d. **ADJUST**—Horiz Width (R1845, Main board) to make fourth pulse leading edge coincide with 60 BEATS/MIN mark.

e. **INTERACTION**—Occurs between Horiz Position and Horiz Width adjustments. Repeat steps A5-a through A6-d as necessary.

f. **CHECK**—100 mm/SEC sweep speed (see Fig. 5-6B). Third pulse leading edge should coincide with 45 BEATS/MIN mark, within 3 mm.

NOTE

The 12.5 and 25 mm/SEC sweep speeds are not triggered. Therefore it will be necessary to measure the distance between pulses using a centimeter rule.

g. **CHECK**—25 mm/SEC sweep speed is accurate within 5% (see Fig. 5-6C).

h. Change function generator frequency to 2 Hz (verify with universal counter).

i. **CHECK**—12.5 mm/SEC sweep speed accurate within 5% (Fig. 5-6D).

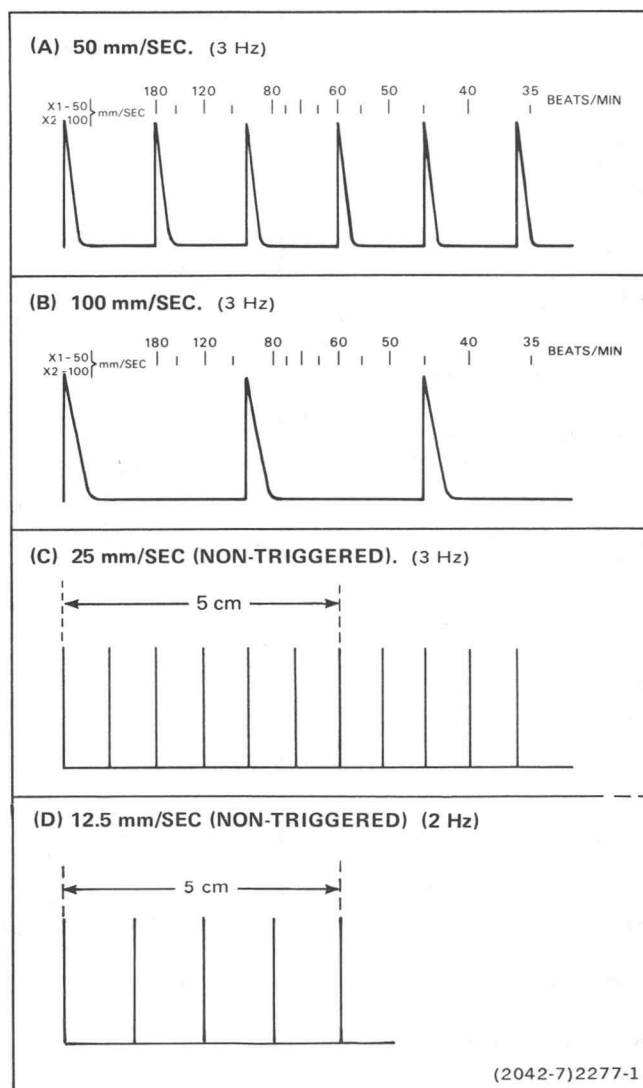


Figure 5-6. Horizontal Width adjustment.

B. ECG

Equipment Required

- | | |
|---|--|
| 1. Patient cable (Tektronix Part 012-0739-00) | 5. Stereo phone plug (Fig. 5-1C) |
| 2. ECG Shorting Connector (Fig. 5-1B) | 6. CMRR/Leakage test fixture (Fig. 5-2B) |
| 3. Test oscilloscope | 7. Precision attenuator (Fig. 5-2A) |
| 4. Function generator | |

BEFORE YOU BEGIN, see

TEST POINT AND
ADJUSTMENT LOCATIONS

in the diagrams section.

B1. INPUT OFFSET NULL

a. Set:

DISPLAY OFF (Resp).....In (off)
 DISPLAY OFF
 (Press/Pulse).....In (off)
 ECG I.....In

b. Connect ECG shorting connector (See Fig. 5-1B) to ECG INPUT connector.

c. **CHECK**—Voltage level at TP183 (ECG board) should be 0.0 V, within 200 mV. Use test oscilloscope.d. **ADJUST**—Input Offset Null (R180, ECG board) for 0.0 V.

B2. DC LEVEL

a. Insert stereo phone plug (Fig. 5-1C) into ECG/RATE OUTPUT connector.

b. **CHECK**—ECG/RATE OUTPUT (TIP) should be 0.0 V, within 25 mV. Use test oscilloscope.c. **ADJUST**—DC Level (R200, ECG board) for 0.0 V.d. **CHECK**—Trace is vertically centered at 75 mmHg line, within 3 mm.

e. Remove ECG shorting plug.

B3. ECG OUTPUT GAIN

a. Connect function generator to test oscilloscope and through precision attenuator (See Fig. 5-2A) to ECG INPUT connector. Apply 1.0 V, 10 Hz sine wave. Note reference amplitude on test oscilloscope. Then connect test oscilloscope to ECG OUTPUT (TIP).

b. **CHECK**—ECG/RATE OUTPUT (TIP) should be equal to reference amplitude, noted in part a.c. **ADJUST**—Gain (R195, ECG board) for output equal to reference amplitude.

d. Disconnect test oscilloscope, function generator, stereo phone Plug, and precision attenuator.

B4. ECG LEAD CHECK SIGNAL

a. Connect ECG LEAD CHECK signal to ECG INPUT connector through patient cable. Leads connect front to back as follows: LL (red) LA (black), RA (white).

b. **CHECK**—Positive-going pulses should be approximately 100 bpm (not critical). Rise and fall times are slow to activate QRS detector (produces audio beat).

c. Set ECG SIZE to index mark (20 mm/mV).

d. **CHECK**—Approximate pulse amplitude for each of the three ECG lead configurations is as follows: I, 2 cm; II, 3 cm; III, 1 cm.

B5. LEAD FAULT OPERATION

a. **CHECK**—LEAD FAULT lamp lights when any ECG lead is removed from an ECG LEAD CHECK terminal.

b. Reconnect lead to ECG LEAD CHECK terminal.

B6. QRS TIMING

a. Connect test oscilloscope channel 1 input to TP360 (ECG board) and channel 2 input to TP371 (ECG board). Trigger oscilloscope on channel 1, (+ slope).

b. Set test oscilloscope vertical mode to CHOP.

c. **CHECK**—Interval to first positive-going edge at TP360 is 5 ms, ± 1 ms (see Fig. 5-7).

B7. QRS WIDTH

a. Set test oscilloscope vertical mode to channel 2. Trigger oscilloscope on composite or normal, + slope.

b. **CHECK**—Pulse duration at TP371 (ECG board) is 150 ms, ± 25 ms (see Fig. 5-8).

c. Disconnect test oscilloscope.

B8. PACER SIGNAL REJECTION

a. Connect pacer input circuit adapter and function generator as shown in Fig. 5-2C.

b. Set function generator output for approximately 500 mV, 1 Hz square wave.

c. Set monitor ECG I button in.

d. **CHECK**—QRS detector (triggers beat tone) should respond only to ECG LEAD CHECK signal and not to simulated pacer signal. When pacer signal coincides with leading edge of ECG LEAD CHECK signal, QRS selection should occur at trailing edge.

e. Disconnect function generator and pacer input circuit adapter.

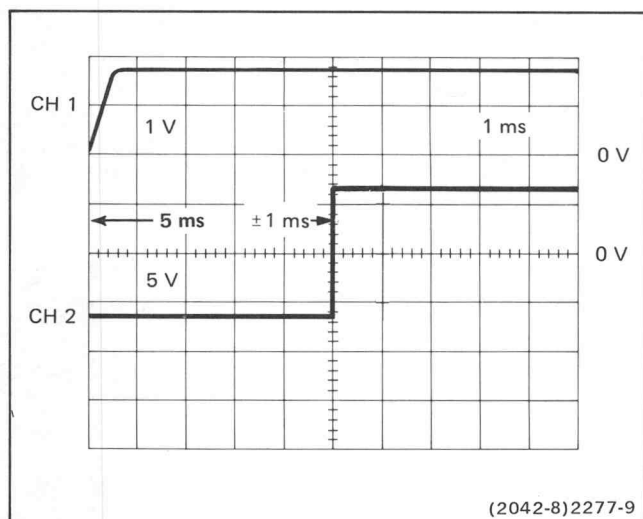


Figure 5-7. QRS timing.

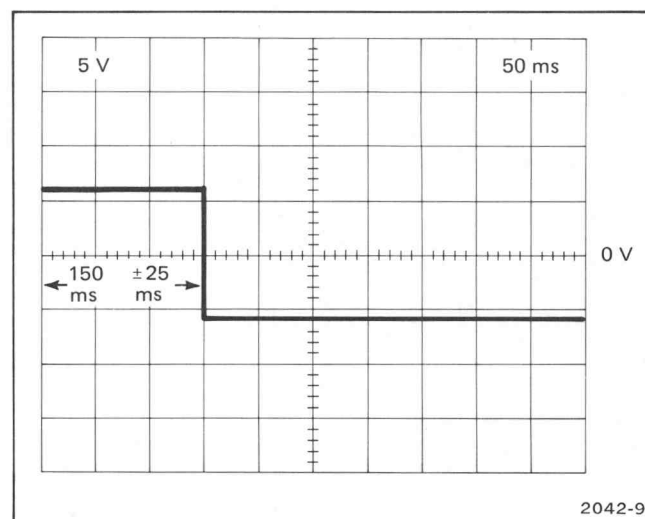


Figure 5-8. QRS width.

C. RESPIRATION

Equipment Required

- | | |
|---|---------------------------------|
| 1. Patient cable (Tektronix Part 012-0739-00) | 3. Stereo phone plug (Fig 5-1C) |
| 2. Respiration test fixture (Fig. 5-4) | 4. Test oscilloscope |

BEFORE YOU BEGIN,

TEST POINT AND
ADJUSTMENT LOCATIONS

in the Diagrams section.

C1. NULL

a. Set:

ECG OFFIn (off)
 DISPLAY OFF (Resp).....Out (on)
 DISPLAY OFF (Press).....In (off)
 RESPIRATION SIZEMidpoint (dot on panel)

b. Connect Respiration test fixture to ECG/RESPIRATION INPUT via patient cable as shown in Fig. 5-4.

c. Set Chest Impedance switch on respiration test fixture to 750 Ω (center) position.

d. **CHECK**—Voltage level at TP441 (Respiration board) should be 0.0 V within 200 mV. Use test oscilloscope.

e. **ADJUST**—Null (R425, Respiration board) for 0.0 V at TP441.

C2. BALANCE

a. Insert stereo phone plug (Fig. 5-1C) into PRESS/PULSE RESPIRATION OUTPUT connector on rear panel.

b. **CHECK**—RING contact should be 0.0 V, ± 25 mV. Use test oscilloscope.

c. **ADJUST**—Balance (R455, Respiration board) for 0.0 V on RING contact.

d. **CHECK**—Trace is vertically centered at 75 mmHg line, ± 3 mm (± 0.3 div).

C3. GAIN

a. Alternately press and release $\Delta 1 \Omega$ pushbutton on respiration test fixture at about 1 second intervals.

b. **CHECK**—Crt beam is deflected 2 cm ± 2 mm each time the $\Delta 1 \Omega$ pushbutton is pressed or released.

c. **ADJUST**—Gain (R540 Respiration board) so that crt beam is deflected 2 cm each time $\Delta 1 \Omega$ pushbutton is pressed or released.

C4. CHEST IMPEDANCE RANGE CHECK

a. Set switch on respiration test fixture to 0 Ω position.

b. **CHECK**—LEAD FAULT LED is on while respiration display is momentarily off screen and goes off as respiration display returns to screen.

c. Set switch on respiration test fixture to 1.5 k Ω position.

d. **CHECK**—INSPIRATION light comes back on within 30 seconds.

e. **CHECK**—LEAD FAULT LED is on while respiration display is momentarily off screen and goes off as respiration display returns to screen.

D. DIGITAL DISPLAY

Equipment Required

- | | |
|---|------------------------|
| 1. Digital voltmeter (test DVM) | 3. Pressure transducer |
| 2. Temperature sensor substitution plug,
113° F/45°C (Fig. 5-3A) | |

BEFORE YOU BEGIN, see

TEST POINT AND
ADJUSTMENT LOCATIONS

in the Diagrams section.

D1. DVM ZERO AND DVM CAL

a. Set:

ECG OFFIn (off)
 PRESSURE 0-125In
 DISPLAY OFF (Resp)In (off)
 DISPLAY OFF (Press)In (off)
 MEANIn
 °C/°F (rear panel)°F
 POWEROut (off)

b. Connect pressure transducer to PRESSURE TRANSDUCER INPUT connector on rear panel.

c. Connect test DVM between TP1241 (ground 1) and TP1221 (Conditioner board).

d. Set POWER button in (on).

e. Push and rotate pressure ZERO control for a test DVM reading of 0.0000 within 2 mV (-0.0020 to +0.0020 V).

f. Release ZERO control and wait for test DVM reading to stabilize.

g. **ADJUST**—DVM Zero (R920, DVM board) so that 413 digital display reads about 2; then rotate R920 counterclockwise until reading just starts to alternate between +0 and -0; then continue to rotate R920 about 1/8th of a turn more.

h. Set TEMPERATURE A pushbutton in. Display should blank.

i. Insert a 113°F temperature sensor substitution plug¹ (Fig. 5-3) into TEMPERATURE SENSOR A INPUT jack on rear panel.

j. Move test DVM +lead from TP1221 to P2400-9.

k. **ADJUST**—DVM Cal (R910, DVM board) so that 413 digital display reads same number as test DVM (i.e., if test EVM reads 1.1288, set DVM Cal so that 413 digital display reads 112.9).

l. Set MEAN button in.

m. **INTERACTION**—Occurs between DVM Zero and DVM Cal adjustments. Repeat steps g through l as necessary.

n. Remove pressure transducer, temperature sensor substitution plug and test DVM.

¹The 113° F temperature sensor substitution plug is used to produce an arbitrary high number on the digital display, which is just below the over-range point, for use in setting the DVM Cal adjustment (actual temperature readout will be adjusted in later step). If 0.1% resistors are not available to make the 113°F substitution plug, use the closest 1% values (e.g. 2.61 K for R1 and 13.1 K for R2). Other value combinations can also be used. The important consideration is to produce a reading on the test DVM between 1.00 V and 1.20 V.

E. TEMPERATURE

Equipment Required

1. Digital voltmeter (test DVM)

2. Temperature sensor substitution plugs (Fig. 5-3)

For adjustments and test points, see

TEST POINT AND
ADJUSTMENT LOCATIONS

pull out pages.

NOTE

To ensure specified temperature readout accuracy, the temperature readout adjustments should be set at a Tektronix Medical Products Service Center. If this is not feasible, use the following method to make these adjustments. The accuracy of these adjustments depends directly on the quality and accuracy of the resistors used in the temperature sensor substitution Plugs.

E1. TEMP SPAN

a. Set:

TEMPERATURE AIn
°C/°F°F
POWEROut (off)

b. Connect test DVM between TP1241 (ground #1) and TP1439 (+1.76 V) on Conditioner board.

c. Set POWER button in (on).

d. **CHECK**—test DVM reads 1.759 V, ± 1 count.e. **ADJUST**—Span (R1435, Conditioner board) so that test DVM reads 1.759 V.

f. Remove test DVM.

E2. °F CAL AND °C CAL

NOTE

°F Cal and °C Cal adjustments located on Conditioner board.

a. Insert 77°F temperature sensor substitution plug (Fig. 5-3) into TEMPERATURE SENSOR INPUT A jack on rear panel. Connect test DVM between P2400-9 and TP1241 (ground 1), located on Conditioner board.

b. Using Table 5-3, check test DVM and 413 digital display readings of simulated temperature values for channel A. Adjust °F Cal (R1425) and °C Cal (R1427) as necessary to obtain correct reading on test DVM.

c. Set TEMPERATURE B pushbutton in.

d. Remove 77°F temperature sensor substitution plug from TEMPERATURE SENSOR INPUT A and insert it into TEMPERATURE SENSOR INPUT B. Move + lead of test DVM to P2400-16.

e. Using Table 5-3, check test DVM and 413 digital display readings of simulated temperature values for channel B. Adjust °F Cal (R1485) and °C Cal (R1487) as necessary to obtain correct reading on test DVM.

E3. ΔT ZERO

a. Insert 77 °F temperature sensor substitution plug (Fig. 5-3) into TEMPERATURE SENSOR INPUT A jack on rear panel and a 113 °F plug into INPUT B.

b. Record TEMPERATURE A digital readout and TEMPERATURE B digital readout, then calculate A minus B.

c. Set both TEMPERATURE A and B pushbuttons in at the same time.

d. **CHECK**—Digital display of A minus B is the same as the calculated value, ± 1 count.

e. **ADJUST**— ΔT Zero (R1445, Conditioner board) so that digital display reads same as calculated A minus B value.

f. Remove test DVM and temperature sensor substitution plugs.

TABLE 5-3
Temperature Readout Checks and Adjustments

°F/°C Switch	Temperature Sensor Sub- stitution Plug (Fig. 5-3)	Test DVM Readings at P2400-9 (TEMP A) P2400-16 (TEMP B)	413 Digital Display Reading (Checks Only)	Adjustments
°F	77°F/25°C	$0.7700 \pm 0.0020 \text{ V}^1$	$77.0 \pm 0.5^\circ$	°F Cal Temp A (R1425) Temp B (R1485)
°C	77°F/25°C	0.2500 ± 0.0010^1	$25.0 \pm 0.3^\circ$	°C Cal Temp A (R1427) Temp B (R1487)
°C	41°F/5°C	²	$5.0 \pm 0.3^\circ$	Check Only
°F	41°F/5°C	²	$41.0 \pm 0.5^\circ$	Check Only
°F	113°F/45°C	²	$113.0 \pm 0.5^\circ$	Check Only
°C	113°F/45°C	²	$45.0 \pm 0.3^\circ$	Check Only

¹If you cannot obtain the accuracy indicated, it will be necessary to readjust the Span, °C Cal and °F Cal adjustments and slightly compromise the settings.

²Test DVM reading for these temperature values are equivalent to 10 mV/degree.

F. PRESSURE/PULSE

Equipment Required

- | | |
|---------------------------------|----------------------------------|
| 1. Manometer | 4. Stereo phone plug (Fig. 5-1C) |
| 2. Pressure transducer | 5. Pulse sensor |
| 3. Digital voltmeter (test DVM) | |

For adjustments and test points, see

TEST POINT AND
ADJUSTMENT LOCATIONS

pull out pages.

F1. GAGE FACTOR

a. Set:

PRESS 0-125.....In
DISPLAY OFF (Press).....In (off)
PULSE ALARM.....Out (off)
MEAN.....In

b. Connect manometer to pressure transducer and pressure transducer to PRESSURE TRANSDUCER INPUT connector on rear panel. Connect test DVM between P2400-27 and TP1241 (ground 1), located on Conditioner board.

c. Press in ZERO control and adjust for test DVM reading of 0.0000, within 0.0200 V. Record exact reading for use in later steps.

d. Apply 125 mmHg pressure as indicated by manometer. Make sure pressure remains at 125 mmHg and is not slowly diminishing.

e. **ADJUST**—Gage Factor (R865, Pressure/pulse board) for test DVM reading of 1.2500 ± 0.0100 V plus reading noted in step c. Record exact reading.

f. Release manometer pressure.

g. **CHECK**—Test DVM reading equals reading noted in step e minus 1.2500, ± 0.0200 V.

h. **INTERACTION**—Can occur between Pressure ZERO and Gage Factor adjustments. Repeat steps c through g as necessary until difference between pressure reading at 0 mmHg and 125 mmHg is $1.2500, \pm 0.0100$ V.

i. Apply 125 mmHg pressure as indicated by manometer.

j. **CHECK**—413 digital display reads 125, ± 3 mmHg.

k. Apply 75 mmHg pressure as indicated by manometer.

l. **CHECK**—Digital display reads 75, ± 3 mmHg.

m. Apply 25 mmHg pressure as indicated by manometer.

n. **CHECK**—Digital display reads 25, ± 1 mmHg.

o. Set SYST/DIAST pushbutton in.

p. Apply 125 mmHg pressure as indicated by manometer.

q. **CHECK**—Digital display reads 125, ± 3 mmHg.

r. Release manometer pressure.

s. Remove test DVM.

F2. TRACE ZERO AND VERTICAL SENSITIVITY

a. Set DISPLAY OFF (Press) out (off).

b. Press in ZERO control and adjust for digital display reading of ± 0 . Release ZERO control.

c. **CHECK**—Trace should coincide with ZERO graticule line, ± 1 mm.

d. **ADJUST**—Trace ZERO (R690, Pressure/pulse boards) to make trace coincide with ZERO graticule line.

e. Apply 125 mmHg pressure as indicated by digital display.

f. **CHECK**—Trace should coincide with 125 mmHg graticule line, ± 1 mm (0.1 div.).

g. **ADJUST**—Vertical Sensitivity (R1685, Main board) to correct one half crt display error.

h. **INTERACTION**—Occurs between Vertical Sensitivity and Trace Zero adjustments. Repeat steps b through g as necessary.

F3. PRESSURE/PULSE OUTPUT

- a. Release manometer pressure.
- b. Insert stereo phone plug (Fig. 5-1c) into PRESSURE/PULSE OUTPUT jack and connect test DVM between TIP and barrel (chassis ground).
- c. Press in ZERO control and adjust for digital display reading of ± 0 . Release ZERO control.
- d. **CHECK**—test DVM reads 0, ± 5 mV.
- e. Apply 125 mmHg pressure as indicated by 413 digital display.
- f. **CHECK**—test DVM reads 1.25 V, ± 25 mV.
- g. Remove test DVM and stereo phone plug.

F4. PRESSURE ALARM

- a. Set ALARM LOUDNESS (rear panel) to midrange.
- b. Simulate a pulsatile pressure display by pressing and releasing the 100 mm CHECK button approximately once every second. Set PULSE ALARM in (on). Continue to press and release 100 mm CHECK button for more than 30 seconds and check that alarm is not triggered.
- c. Stop pressing 100 mm CHECK button.
- d. **CHECK**—Alarm is triggered within about 30 seconds.

- e. Set PULSE ALARM button out (off).
- f. Disconnect manometer and pressure transducer.

F5. PULSE DISPLAY

- a. Set PULSE button in.
- b. Connect Pulse sensor to PULSE SENSOR INPUT on rear panel and monitor your pulse.
- c. **CHECK**—Monitor displays pulse. Digital display is blanked.

F6. PULSE ALARM

- a. Set PULSE ALARM button in (on).
- b. **CHECK**—Alarm is not triggered after waiting more than 30 seconds.
- c. Disconnect Pulse sensor.
- d. **CHECK**—Alarm is triggered within 3-15 seconds.
- e. Push in ALARM RESET.
- f. **CHECK**—Audible alarm ends and ALARM light remains on.
- g. Set PULSE ALARM and ALARM RESET buttons out.
- h. **CHECK**—Alarm light is off.

G. RATE

Equipment Required

- | | |
|--------------------------------|---------------------------|
| 1. Function generator | 4. Test oscilloscope |
| 2. Low-pass filter (Fig. 5-1A) | 5. Universal counter |
| 3. Test DVM | 6. 10 M Ω resistor |

For adjustments and test points, see

TEST POINT AND
ADJUSTMENT LOCATIONS

in the pullout pages.

G1. HEART RATE

a. Set:

ECG IIn
LOW RATE LIMITRATE ALARM OFF
HEART RATE/MINIn
DISPLAY OFF (Press)In (off)

b. Connect function generator square wave through low-pass filter (Fig. 5-1A) to ECG INPUT connector and display about 4 cm at 3 Hz (180 bpm). Verify function generator frequency with universal counter. Connect test DVM between P2400-11 and TP1241 (ground 1), located on Conditioner board.

c. **ADJUST**—Heart Rate (R1315, Conditioner board) so that test DVM reads 1.8000, ± 0.0100 V.

d. **CHECK**—413 digital display reads 180, ± 3 .

e. Set function generator to 1 Hz (verify with universal counter). Wait 15 seconds.

f. **CHECK**—Digital display reads 60, ± 3 .

g. Set function generator to 4 Hz (verify with universal counter). Wait for 15 seconds.

h. **CHECK**—Digital display reads 240, ± 5 .

i. Turn off function generator.

j. **CHECK**—Digital display reads 0 to 3.

k. Turn on function generator.

G2. RATE OUTPUT

a. Insert stereo phone plug into ECG/RATE OUTPUT jack on rear panel.

b. Connect test oscilloscope to RATE OUTPUT (RING).

c. **CHECK**—An approximate 68 ms, 5.5 V pulse occurs for each ECG pulse.

d. Disconnect test oscilloscope and stereo phone plug.

G3. RESPIRATION RATE

a. Connect a 10 M Ω resistor between TP371 on the ECG board and TP441 on the Respiration board.

b. Set function generator frequency so that the test DVM reads 0.7500 to 0.8000 V (test DVM should still be connected to P2400-11). Record exact readings on test DVM and on 413 digital display.

c. Set:

DISPLAY OFF (Resp)Out (on)
RESPIRATION SIZEMidpoint (dot on panel)
RESP RATE/MINIn

d. **CHECK**—INSPIRATION light goes on with each positive-going excursion of the displayed pulse.

e. Connect test DVM between P2400-33 and TP1241 (ground 1), located on Conditioner board.

NOTE

It can take up to one minute after signal is applied and the respiration channel is turned on for an accurate reading to be displayed on the test DVM.

f. **ADJUST**—Respiration Rate (R1345, Conditioner board) so that test DVM reads same as value for heart rate recorded in an earlier step, within 0.0100 V. Note that response to control is very slow.

g. **CHECK**—413 digital display reads the same as the heart rate recorded in an earlier step, within 2 beats/minute.

h. Disconnect 10 M resistor and set DISPLAY OFF (RESP) in.

G4. HEART RATE ALARM LIMITS

a. Set:

ALARM LOUDNESS
(rear panel).....Midrange
LOW RATE LIMIT
(press for digital display)116
HIGH RATE LIMIT
(press for digital display)124

b. Set function generator frequency to read 120, ± 1 bpm on digital display.

c. Press LOW RATE LIMIT control in and set to read 124 on digital display.

d. **CHECK**—Alarm tone sounds and ALARM light turns on within 30 seconds.

e. Press in RESET button.

f. Set LOW RATE LIMIT to read 116 on digital display.

g. Press HIGH RATE LIMIT control in and set to read 116 on digital display.

h. **CHECK**—Alarm tone sounds and alarm light turns on within 30 seconds.

i. Set LOW RATE LIMIT control to RATE ALARM OFF.

j. Set HIGH RATE LIMIT control to 150 (printed on front panel). Press control in and check that digital display reads 150, ± 15 bpm. Repeat check at 90 and 240 for digital display readings within 5 bpm. Loosen set screw and readjust knob on shaft to make panel settings and digital display within 15 bpm of each other at 150 and within 5 bpm at 90 and 240.

k. Set HIGH RATE LIMIT fully clockwise.

l. Set LOW RATE LIMIT control to 90 (printed on front panel). Reset alarm as necessary. Press control in and check that digital display reads 90, ± 15 . Repeat check at 30 and 150 for digital display reading within 5 bpm. Loosen set screw and readjust knob on shaft to make front-panel settings and digital display within 15 bpm of each of other at 90 and with 5 bpm at 30 and 150.

m. Disconnect function generator and low-pass filter.

H. ECG LEAKAGE AND COMMON MODE REJECTION RATIO (CMRR)

Equipment Required

- | | |
|------------------------------|--|
| 1. Test oscilloscope | 3. Leakage test fixture (Alternative method) |
| 2. CMRR/leakage test fixture | |

H1. ECG LEAKAGE CHECK

This check determines the amount of leakage current that could be present between the patient and the ECG circuit of the monitor under either of the following abnormal conditions:

- (1) Monitor is properly grounded and patient is at 120 Vac, 60 Hz, or
- (2) Monitor is not grounded, case is connected to 120 Vac, 60 Hz and patient is grounded.

TEST EQUIPMENT REQUIRED

Use an instrument such as the Model 431 Safety Analyzer, manufactured by Neutrodyne-Dempsey Inc., P.O. Box 1925, Carson City, Nevada.

LEAKAGE CHECK PROCEDURE

- a. Disconnect monitor from ac power source.
- b. Remove top and bottom covers.
- c. CHECK—All plug-in circuit boards are pushed firmly into their mating receptacles.
- d. CHECK—All cables are plugged firmly into their mating pins and that they are dressed away from ECG shield, input connector shield and pushbutton switch shafts.
- e. CHECK—Screw and spacer securing ECG circuit board are tight. See Figure 5-9.
- f. CHECK—Plastic board retainer is installed and properly seated at top of circuit boards.
- g. Replace top and bottom covers. Leakage check is valid only with covers installed.

- h. Check ECG-leakage current using procedure supplied by the Safety Analyzer manufacturer.

H2. ECG CMRR CHECK

- a. Connect CMRR test fixture (Figure 5-2B) to ECG INPUT connector. Then connect test circuit to ac-power line.
- b. Set ECG SIZE control to midrange mark (20 mm/mV).
- c. Set ECG button in.
- d. CHECK—Monitor display amplitude should be less than 1.3 cm p-p for nominal 115 V lines (or less than 2.6 cm, p-p for nominal 230 V lines, if the lines are unbalanced).

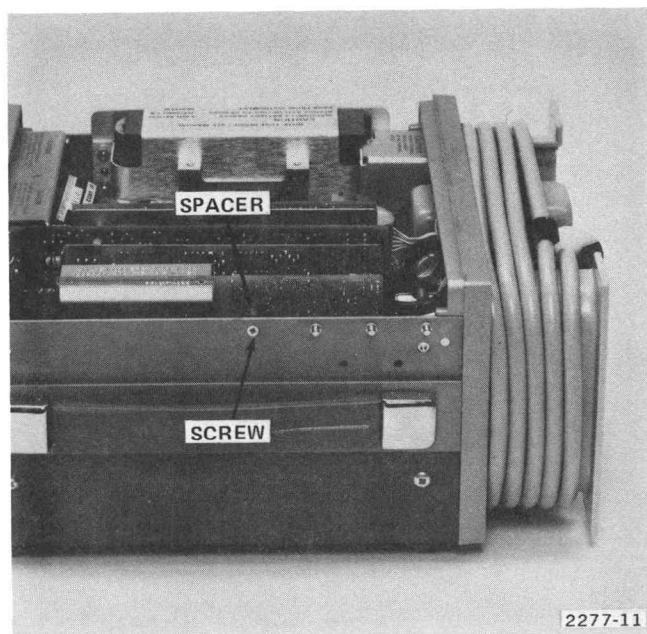


Figure 5-9. ECG board securing.

e. Set ECG III in.

f. Repeat part d.

g. Set ECG II in.

h. CHECK—Monitor display amplitude should be less than 1.9 cm p-p for nominal 115 V lines (or less than 3.8 cm, p-p for nominal 230 V lines, if the lines are unbalanced).

i. Disconnect CMRR test fixture.

SHORT FORM ADJUSTMENT PROCEDURE

For adjustments and test points, see

TEST POINT AND
ADJUSTMENT LOCATIONS

in the pullout pages.

PURPOSE

This procedure does not validate all published performance requirements. This short-form adjustment procedure is intended to permit rapid touchup of all internal adjustments, under the assumption that the monitor is functioning correctly in all respects, and that the service person is familiar with the methods described in the Check/Adjust procedure.

This procedure is divided by major functions to permit adjustment to individual circuits without having to perform a complete readjustment. However, if the +5 volt setting is changed, the entire monitor should be readjusted. When making partial adjustments, always set controls according to Preliminary Setup below.

PRELIMINARY SETUP

POWERIn (on)
DISPLAY OFF (Resp).....In (off)
DISPLAY OFF
(Press/Pulse).....In (off)
OFF (ECG)In (off)
LOW RATE LIMIT.....RATE ALARM OFF (ccw)
SWEEP SPEED
MM/SEC 100.....In
BEAT LOUDNESS.....Midrange

Set remaining controls as desired. Connect the monitor to the correct ac line source. DO NOT PRESET INTERNAL CONTROLS.

NOTE

Do not adjust the +5V supply if it is within 25 mV unless a complete recalibration is intended.

POWER SUPPLY AND DISPLAY

1. +5 VOLTS

SETUP—Connect Test DVM between ground and TP1994 (+5V).

ADJUST—+5 V (R1990) for +5.0 V

2. CLOCK

SETUP—Connect test oscilloscope to TP1623.

ADJUST—Clock (R1610) for square-wave period of 500 μ s (2 kHz).

3. TRACE ROTATION

ROTATE—Yoke for non-tilted trace.

NOTE

Keep monitor upright when adjusting spot centering. Horizontal Position, and Horizontal Width.

4. SPOT CENTERING AND FOCUS

SETUP—Unplug yoke plug (P1690).

ADJUST—Centering rings for centered spot.

ADJUST—Focus (R2140) for smallest round spot.

5. HORIZONTAL POSITION

SETUP—Reconnect yoke plug (P1690).

ADJUST—Horiz Position (R1835) to make trace start at left end of graticule.

6. HORIZONTAL WIDTH

Set:

ECG IIn
SWEEP SPEED
mm/SEC 50.....In

SETUP—Connect function generator through low-pass filter to ECG INPUT connector. Display 4 cm, 3 Hz.

ADJUST—Horiz Width (R1845) to make fourth pulse coincide with 60 BEATS/ MIN mark.

ECG

7. INPUT OFFSET NULL

Set:

ECG IIn
 DISPLAY OFF (Resp).....In (off)
 DISPLAY OFF
 (Press/Pulse).....In (off)

SETUP—Connect ECG shorting connector to ECG INPUT.

ADJUST—Input Offset Null (R180) for 0.0V.

8. DC LEVEL

SETUP—Connect test oscilloscope to ECG/RATE OUTPUT (TIP) through stereo phone plug.

ADJUST—DC Level (R200) for 0.0V.

9. ECG OUTPUT GAIN

SETUP—Connect function generator to test oscilloscope through precision attenuator to ECG OUTPUT. Apply 1.0 V, 10 Hz sine wave. Note reference amplitude on oscilloscope. Then connect oscilloscope to ECG RATE OUTPUT (TIP).

ADJUST—Gain (R195) for output equal to reference amplitude.

RESPIRATION

10. NULL

Set:

ECG OFFIn (off)
 DISPLAY OFF (Resp).....Out (on)
 DISPLAY OFF
 (Press/Pulse).....In (off)
 RESPIRATION SIZEMidpoint

SETUP—Connect respiration test fixture to ECG/RESPIRATION INPUT via patient cable. Set switch on test fixture to 750 Ω (center) position. Connect test oscilloscope to TP441.

ADJUST—Null (R425) for 0.0V.

11. BALANCE

SETUP—Insert stereo phone plug into PRESSURE/PULSE RESPIRATION OUTPUT connector on rear panel. Connect test oscilloscope to RING contact.

ADJUST—Balance (R455) for 0.0 V.

12. GAIN

ADJUST—Gain (R540) so that crt beam is deflected 2 cm each time [Δ]1 Ω pushbutton (on respiration test fixture) is pressed or released.

DIGITAL DISPLAY

13. DVM ZERO AND DVM CAL

Set:

ECG OFFIn (off)
 PRESSURE 0-125In
 DISPLAY OFF (Resp).....In (off)
 DISPLAY (Press/Pulse).....In (off)
 MEANIn
 °C/°F (rear panel)°F
 POWEROut (off)

SETUP—Connect pressure transducer to PRESSURE TRANSDUCER INPUT connector. Connect test DVM between TP1241 (ground #1) and TP1221. Set POWER button in (on). Press in ZERO control and rotate to read 0.0000 \pm 0.0200 V on test DVM.

ADJUST—DVM Zero (R920) so that 413 digital display reads about 2; then rotate R920 counterclockwise until reading just starts to alternate between +0 and -0; then continue to rotate R920 about 1/8th of a turn more.

SETUP—Insert 113°F temperature sensor substitution plug into TEMPERATURE SENSOR INPUT jack. Move test DVM +lead from TP1221 to P2400-9.

ADJUST—DVM Cal (R910) so that 413 digital display reads same number as test DVM (i.e., if test test DVM reads 1.1288, set DVM Cal so that 413 digital display reads 112.8).

INTERACTION—Repeat DVM Zero and DVM Cal adjustments as necessary.

TEMPERATURE

14. TEMP SPAN

Set:

TEMPERATURE AIn
 °C/°F (rear panel)°F
 POWEROut (off)

SETUP—Connect test DVM between TP1241 (ground #1) and TP1439 (+1.76 V). Set POWER button in (on).

ADJUST—Span (R1435) so that test DVM reads 1.759V.

15. °F CAL AND °C CAL

SETUP—Insert 77°F temperature sensor substitution plug into TEMPERATURE SENSOR INPUT A. Connect test DVM +lead to P2400-9.

ADJUST—TEMP A °F Cal (R1425) for test DVM reading of 0.7700 ± 0.0020 V.

SET—°C/°F switch to °C.

ADJUST—Temp A °C Cal (R1427) for test DVM reading of 0.2500 ± 0.0010 V.

SETUP—Insert 77°F temperature sensor substitution plug into TEMPERATURE SENSOR INPUT B. Connect test DVM +lead to P2400-16.

ADJUST—Temperature B °C Cal (R1487) for test DVM reading of 0.2500 ± 0.0010 V.

SET—°C/°F switch to °F.

ADJUST—Temp B °C Cal (R1485) for test DVM reading of 0.7700 ± 0.0010 V.

16. T ZERO

SETUP—Insert 77°F temperature sensor substitution plug into TEMPERATURE SENSOR INPUT A. Insert 113°F plug into INPUT B.

RECORD—Temp A readout and Temp B readout.

CALCULATE—Temp A minus B.

SET—Both Temperature A and B pushbuttons in at the same time.

ADJUST—T Zero (R1445) for same reading as calculated value.

PRESSURE/PULSE**17. GAGE FACTOR**

Set:

PRESS 0-125.....In
 DISPLAY OFF
 (Press/Pulse).....In (off)
 PULSE ALARMOut (off)
 MEANIn

SETUP—Connect manometer to pressure transducer and pressure transducer to PRESSURE TRANSDUCER INPUT. Connect test DVM +lead to P2400-27. Press in ZERO control and adjust for test DVM reading of 0.0000 ± 0.0200 V; note exact reading. Apply 125 mmHz pressure.

ADJUST—Gage Factor (R865) for test DVM reading of 1.2500 ± 0.0100 V plus reading previously noted for ZERO setting.

INTERACTION—Readjust ZERO control and Gage Factor adjustment as necessary.

18. TRACE ZERO AND VERTICAL SENSITIVITY

SETUP—Set DISPLAY OFF button out (on). Press in ZERO control and adjust for +0 on digital display.

ADJUST—Trace Zero (R690) to make trace coincide with ZERO graticule line.

SETUP—Apply 125 mmHz pressure.

ADJUST—Vertical Sensitivity (R1685) to correct one half of crt display error.

INTERACTION—Readjust Trace Zero and Vertical Sensitivity as necessary until display error is eliminated.

RATE**19. HEART RATE**

Set:

ECG I.....In
 LOW RATE LIMIT.....RATE ALARM OFF
 HEART RATE/MININ
 DISPLAY OFF
 (Press/Pulse).....In (off)

SETUP—Connect function generator through low-pass filter to ECG INPUT. Display 4 cm at 3 Hz (180 bpm). Connect test DVM +lead to P2400-11.

ADJUST—Heart Rate (R1315) for test DVM reading of 1.8000 ± 0.0100 V.

20. RESPIRATION RATE

SETUP—Conect 10 MΩ resistor between TP371 (ECG board) and TP441 (Respiration board). Set function generator frequency so that test DVM reads 0.7500 to 0.8000 V for heart rate. Record exact reading. Move test DVM +lead to P2400-33.

Set:

DISPLAY OFF (Resp).....Out (on)
 RESPIRATION SIZEMidpoint (dot on panel)
 RESPIRATION RATE/MIN.....In

ADJUST—Respiration Rate (R1345) so that test DVM reads same as heart rate (recorded in previous step).

NOTE

ECG leakage checks should be performed after readjustment. Refer to Check/Adjust procedure.

OPTIONS

Your instrument may be equipped with one or more instrument options. A brief description of each available option is given in the following discussion. Option information is incorporated into the appropriate sections of the manual. Refer to Table 6-1 for location of option information. For further information on instrument options, see your Tektronix Catalog or contact your Tektronix Field Office.

OPTION 2—EXTERNAL PRESSURE GAGE-FACTOR ADJUSTMENT

Adds Pressure Gage-Factor control to rear panel to accommodate non-standard transducers.

OPTION 5—BEAT-TO-BEAT RATE CONVERTER

Changes the RATE OUTPUT signal to a voltage that is linearly related to heart rate on a beat-to-beat basis. The voltage output is equivalent to 10 mV per beat/minute.

OPTION 20—NO PRESSURE FUNCTIONS

Removes all controls, connectors, and graticule graduations associated with the blood pressure function.

OPTION 22—ADULT VERSION

Expands the pressure scale ranges, and reduces the respiration rate alarm limits to accommodate only adult characteristics.

TABLE 6-1
Option Information Locator

Instrument Option	Manual Section	Location of Information
Option 2 (External Pressure Gage-Factor Adjustment)	6 Replaceable Electrical Parts	External GAGE FACTOR control (R866) referenced by footnote.
	7 Options	Option 2 Provides a description, a partial schematic diagram, and a calibration procedure.
	9 Replaceable Mechanical Parts	Option 2 mechanical parts referenced by footnotes.
Option 5 (Beat-to-Beat Rate Converter)	6 Replaceable Electrical Parts	Option 5 electrical parts referenced by footnotes.
	7 Options	Option 5 Provides a description, a Theory of Operation and a Calibration procedure.
	8 Diagrams	Beat-to-Beat Rate Converter schematic diagram. 12
	9 Replaceable Mechanical Parts	Option 5 mechanical parts referenced by footnotes.
Option 20 (No pressure functions)	6	Option 20 electrical parts referenced by footnotes.
	7 Options	Option 20 Provides a description and an illustration of the front panel.
	8 Diagrams	Pulse Input & Trace Chopping 13 and Readout Switching 14 schematic diagrams.
	9 Replaceable Mechanical Parts	Option 20 mechanical parts referenced by footnotes.
Option 22 (Adult Version)	6 Replaceable Electrical Parts	Option 22 electrical parts referenced by footnotes.
	7 Options	Option 20 Provides a description and Calibration Procedure changes.
	9 Replaceable Mechanical Parts	Option 22 mechanical parts referenced by footnotes.

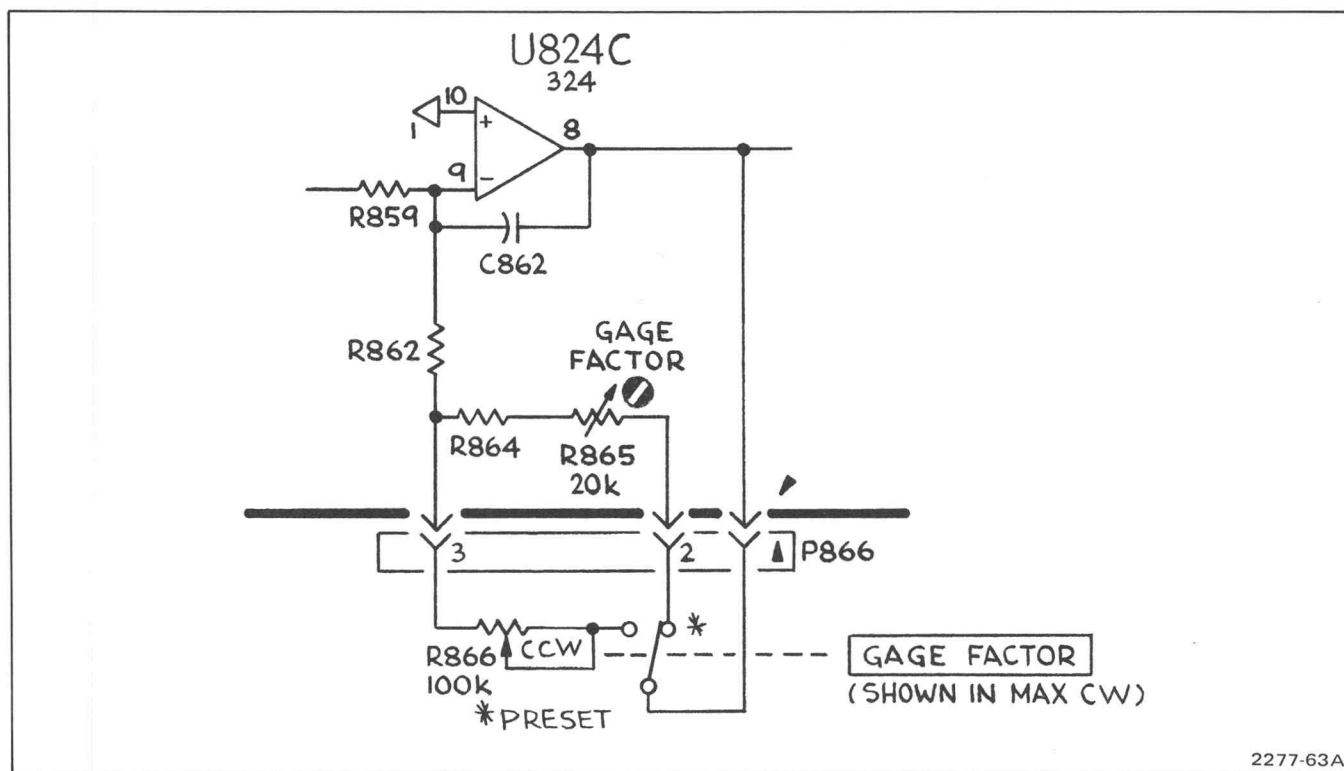
OPTION 2

DESCRIPTION

This option provides operator adjustment of the pressure channel calibration ($\pm 25\%$) to compensate for an uncalibrated pressure transducer. See Option 2—Figure 1. The added GAGE FACTOR control is adjusted to match the monitor's digital display with the reading on a mercury-column manometer.

NOTE

The GAGE FACTOR control must be set fully clockwise (in detent) when the monitor is used with known calibrated pressure transducers. Refer to the following procedure for uncalibrated pressure transducers.



Option 2—Figure 1. Schematic diagram of added external GAGE FACTOR control

OPERATOR CALIBRATION

All sections in this manual are applicable to the 413 Option 2 Monitor plus the following:

Perform the following procedure to calibrate the monitor to an uncalibrated pressure transducer.

1. Connect the equipment as shown in Option 2—Figure 2, and turn on the monitor.

2. Set the 413 Monitor controls as follows:

SWEEP SPEED50 mm/SEC
 PRESS 0-125.....In
 DISPLAY OFF
 (Press/Pulse).....In (off)
 MEAN.....Out

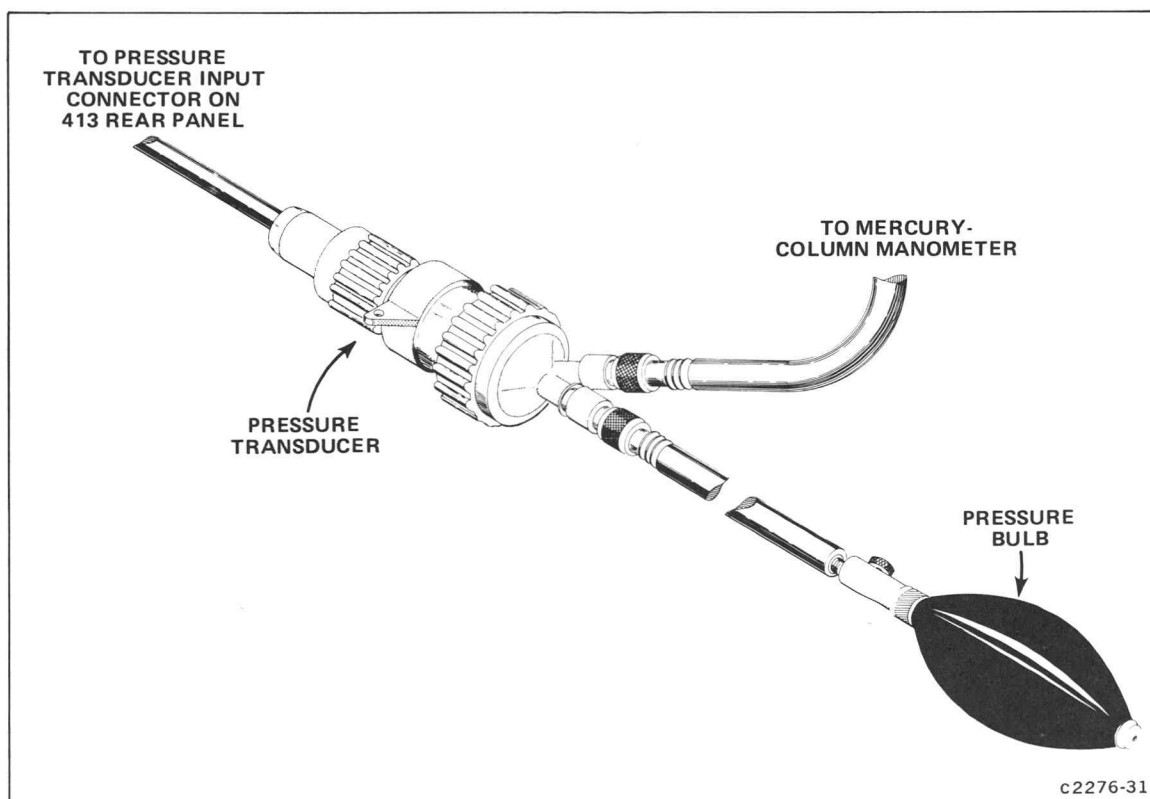
3. Vent the pressure system to atmosphere. Press in and adjust the READOUT ZERO control (on 413 front panel) until the digital display reads + or—0.

4. Close the vent and pressurize the system for a reading of 125 mmHg on the mercury-column manometer.

NOTE

The particular pressure value used in this setup (125 mmHg) is relatively unimportant. However, it is important that the manometer and digital display indications match, both at some pressure value near full scale of the monitor's range.

5. Rotate the rear-panel GAGE FACTOR control counterclockwise (out of detent) until the 413 digital display matches the reading of the mercury-column manometer. The inherent stabilizing time of the digital display may be bypassed by pressing the READOUT PUSH ZERO control, being careful not to disturb the zero setting established in the previous step.



Option 2—Figure 2. Equipment setup to calibrate the monitor with an uncalibrated transducer.

OPTION 5

DESCRIPTION

This option changes the ECG/RATE OUTPUT signal. The RING output changes to a voltage linearly related to heart rate on a beat-to-beat basis. This signal can be connected to an external chart recorder to plot instantaneous heart rate against time (beat-to-beat variability). A rate of zero to about 8 bpm is indicated by zero volts, and 250 bpm by +2.5 volts. All intermediate rates produce a proportional output at the rate of 10 millivolts per beat/minute.

All sections in this manual are applicable to the 413 Option 5 Monitor with the following exceptions and additions:

SPECIFICATIONS

The specifications for the 413 Option 5 are the same as the Standard 413 (Section 1) except as shown in Option 5—Table 1.

All sections in this manual are applicable to the 413 Option 2 Monitor plus the following:

OPTION 5—TABLE 1
Option 5 Electrical Characteristics

Characteristics	Performance Requirements
RATE OUTPUT (rear panel)	
Accuracy (18 to 400 bpm)	2% or 3 bpm whichever is greater.
Step-Response Time	
0-400 bpm	0.4 seconds or less.
400-0 bpm	10 seconds or less.
400-18 bpm	6 seconds or less.

THEORY OF OPERATION

BEAT-TO-BEAT RATE BOARD 12

CIRCUIT FUNCTIONS

The Beat-to-Beat Rate Converter board (mounted to battery pack) converts the Selected Trigger pulse (from Main board) to a voltage output that is equivalent to 10 mV/bpm on a beat-to-beat basis.

CIRCUIT OPERATION

Basically, the Beat-to-Beat Rate Converter circuit operates as follows: (See Option 5—Figure 1). The circuit counts the number of 500 Hz (or pulses per second) that occur between two Selected Trigger pulses. This number of clock pulses is divided into 30,000 to convert the units to beats/minute. The binary value in beats/minute is then converted to an analog voltage level equal to 10 mV/bpm.

The Selected Trigger pulse (heart rate from the Main board) enters the Beat-to-Beat Rate Converter board at P2271 pin 2. The logic level of the pulse is shifted through grounded base amplifier Q2212. The positive-going Selected Trigger pulse turns off Q2212, causing pin 1 of Q2216B to go LO and trigger one-shot U2216B. The trailing edge of the 100 microsecond pulse from pin 5 of U2216B triggers one-shot U2216A. A 50 microsecond pulse at pin 13 resets counter U2240.

The 500 Hz clock pulse at P2271, from the Main board, through level shifter Q2232, clocks counter U2240. Counter U2240 continues to count until the next Selected Trigger pulse occurs, at which time another 100 microsecond pulse occurs at pin 5 of U2216B that clocks latch U2241/U2242. This holds a binary value from counter U2240, representing the number of 500 Hz clock pulses that occurred between the two Selected Trigger

pulses. Since U2216 A is triggered on the trailing edge of the 100 microsecond pulse from U2216B, the 50 microsecond reset pulse at pin 5 of U2216A, is delayed by 100 microseconds. This provides time for U2241/U2242 to be clocked before counter U2240 is reset.

The binary number at Q outputs of latch U2241/U2242, presets down counter U2245/U2246/U2247.

The 500 kHz oscillator (made up of U2256D, U2256F, and U2257A) clocks down counter U2245/U2246/U2247 for exactly 30,000 counts, as determined in counter U2246. Each time the down counter counts to zero, a LO output occurs at pin 7 that clocks counter U2251 and again, through U2256B, presets the down counter to the binary value from U2241/U2242.

At the end of the 30,000 counts, pin 10 of U2257C goes LO, stops counter U2266 and clocks latches U2252/U2253. These latches hold the binary value from counter U2251 at the input at the digital-to-analog converter (R-2R ladder) R2273. R2273 converts the binary value at the outputs of U2252/U2253 to an analog value at the input to U2279A. If the equivalent heart rate is 8 bpm or less, pin 1 (Q12) of counter U2240 goes HI and clocks U2259B which resets U2252/U2253 to zero, making the rate output zero for heart rates 0-8 bpm.

U2279A is a non-inverting operational amplifier whose gain is set by R2273 and R2282. The gain varies with the binary output from U2252/U2253. Zero adjustment, R2280 sets the zero level of the Rate output.

U2279B is a non-inverting operational amplifier with a gain of 1 (set by Gain adjustment, R2290).

CALIBRATION

CHECK/ADJUST PROCEDURE

Replace step G2. RATE OUTPUT in the Check/Adjust Procedure in section 5, with the following:

a. Insert stereo phone plug into ECG/RATE OUTPUT jack on rear panel and connect test DVM to RATE OUTPUT (RING contact).

b. Set ECG OFF pushbutton in (off).

c. **CHECK**—Test DVM reads 0.00 V, plus or minus 0.5 mV.

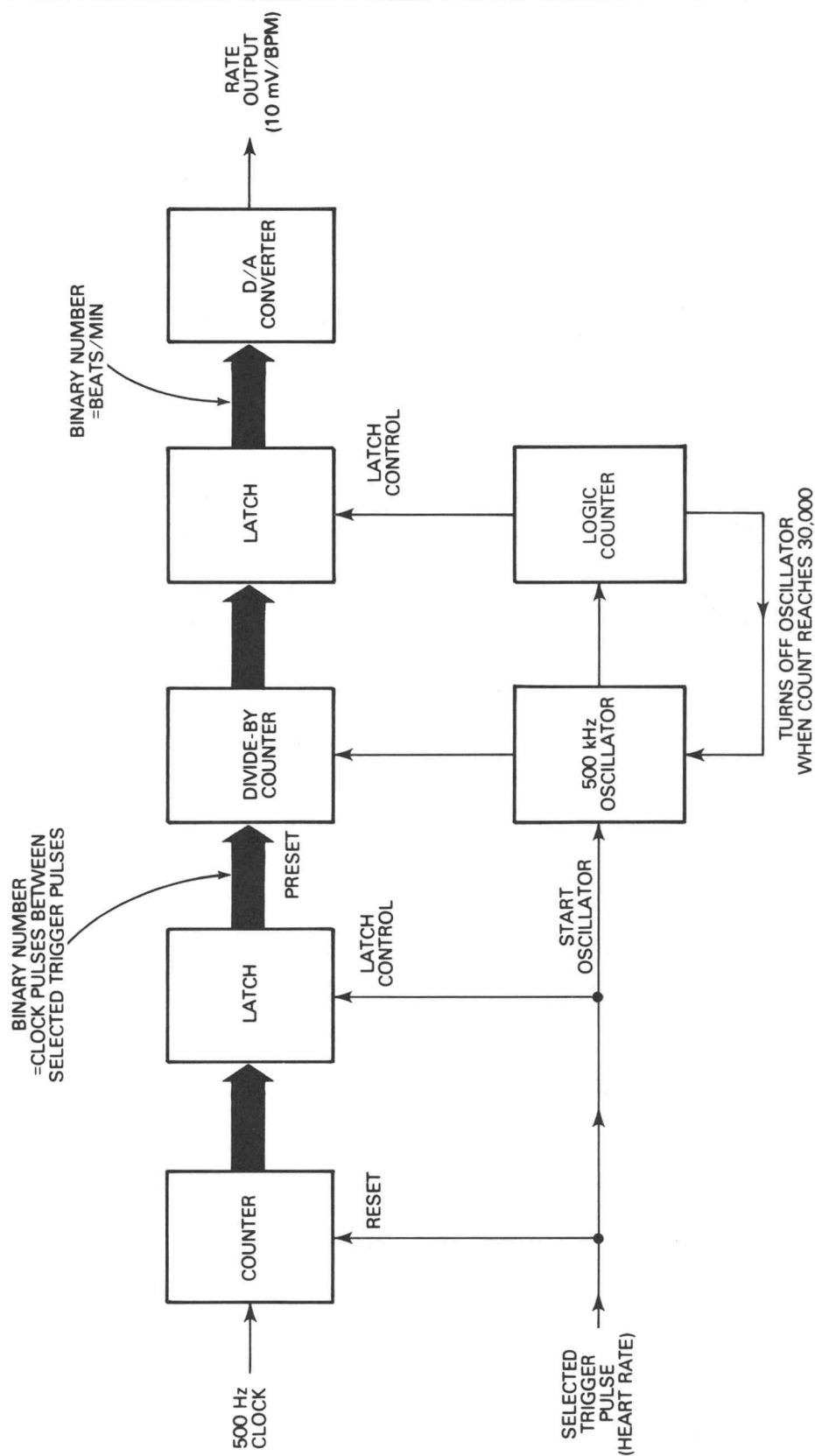
d. **ADJUST**—Zero (R2280) so that test DVM reads 0.00 V, ± 0.5 mV.

e. Set ECG I pushbutton in.

f. **CHECK**—Test DVM reads 2.50 V, ± 30 mV.

g. **ADJUST**—Gain (R2285) so that test DVM reads 2.50 V. This represents 10 mV/bpm.

h. Disconnect test DVM and stereo phone plug.



Option 5—Figure 1. Beat-to-Beat rate converter simplified block diagram.

OPTION 20

DESCRIPTION

The 413 Option 20 is a three-trace monitor for simultaneous display of ECG, Respiration, and Pulse waveforms.

The 413 Option 20 monitor is the same as the standard 413 except that the pressure measurement capability has been deleted.

All sections of this manual are applicable to the 413 Option 20 Monitor except as indicated in the following subsections:

SPECIFICATIONS

All electrical Characteristics remain unchanged from the standard 413, except that all references to pressure modes do not apply.

OPERATING INFORMATION

Option 20—Figure 1 (page 3) shows the front panel for the 413 Option 20. Except for deletion of pressure functions, all controls, connectors, and indicators operate as in the standard 413. See Section 2.

THEORY OF OPERATION

See Section 3. Ignore portions pertaining to pressure.

MAINTENANCE

Maintenance procedures for Option 20 are the same as those for the Standard 413 except that references to Pressure/Pulse board become Pulse board. Schematic diagrams 13 and 14 replace diagrams 3 and 5 directly.

CALIBRATION

CHECK/ADJUST PROCEDURE

Perform the Check/Adjust Procedure as written in Section 5, ignoring all references to pressure and making changes as follows:

D. DIGITAL DISPLAY

D1. DVM ZERO AND DVM CAL

Replace with the following:

a. Set:

ECG OFFIn (off)
 DISPLAY OFF (Resp).....In (off)
 °C/°F (rear panel)°C
 TEMPERATURE A.....In

b. Insert a 5°C temperature sensor substitution plug (Fig 5-3) into TEMPERATURE SENSOR INPUT A on rear panel.

c. Connect test DVM between P2400-9 (Conditioner board) and TP1241 (ground 1).

d. Adjust the Temp A °C Cal (R1427) so that test DVM reads 0.0000 within 2 mV (-0.0020 to +0.0020 V). This is to produce a zero-voltage level to set the DVM Zero adjustment.

e. **ADJUST**—DVM Zero (R920, DVM board) so that 413 digital display reads about 2. Rotate R920 counterclockwise until reading just starts to alternate between +0 and -0; then continue to rotate R920 1/8th of a turn more.

f. Set °C/°F switch (rear panel) to °F.

g. Replace 5°C temperature sensor substitution plug with a 113°F plug (Fig. 5-3). The 113°F temperature value produces an arbitrarily high number on the digital display for setting the DVM Cal adjustment. Actual temperature readout is adjusted in Part E, Temperature.

h. **ADJUST**—DVM Cal (R910, DVM board) so that digital display reads same number as test DVM (i.e., if test DVM reads 1.1288 V, set DVM Cal so that 413 digital display reads 112.9).

i. **INTERACTION**—Occurs between DVM Zero and DVM Cal adjustments. Repeat steps a through h as necessary.

j. Remove temperature sensor substitution plugs.

F. PRESS/PULSE

Delete all but pulse sensor from Equipment Required list.

Delete steps F1 through F4.

SHORT FORM ADJUSTMENT PROCEDURE

PRELIMINARY SETUP

Perform the Short Form Adjustment Procedure as written in Section 5, ignoring all references to pressure and making changes as noted below.

13. DVM ZERO AND DVM CAL

Replace with the following:

Set:

ECG OFFIn (off)
 DISPLAY OFF (Resp).....In (off)
 °C/°F°C
 TEMPERATURE A.....In
 POWEROut (off)

SETUP—Insert 5°C temperature sensor substitution plug into rear-panel TEMPERATURE SENSOR INPUT A jack. Connect test DVM to P2400-9 (Conditioner board) and TP1241 (ground 1). Set POWER button in (on). Adjust °C Cal (R1427) so that test DVM reads 0.0000 within 2 mV (-0.0020 to +0.0020 V).

ADJUST—DVM Zero (R920) so that 413 digital display reads about 2. Rotate R920 counterclockwise until reading just starts to alternate between +0 and -0; then continue to rotate R920 1/8th of a turn more.

SET-°C/°F switch (rear panel) to °F.

SETUP—Remove 5°C temperature sensor substitution plug and insert 113°F substitution plug.

ADJUST—DVM Cal (R910) so that 413 digital display reads same number as test DVM (i.e., if test DVM reads 1.1288 V, set DVM Cal so that 413 reads 112.9).

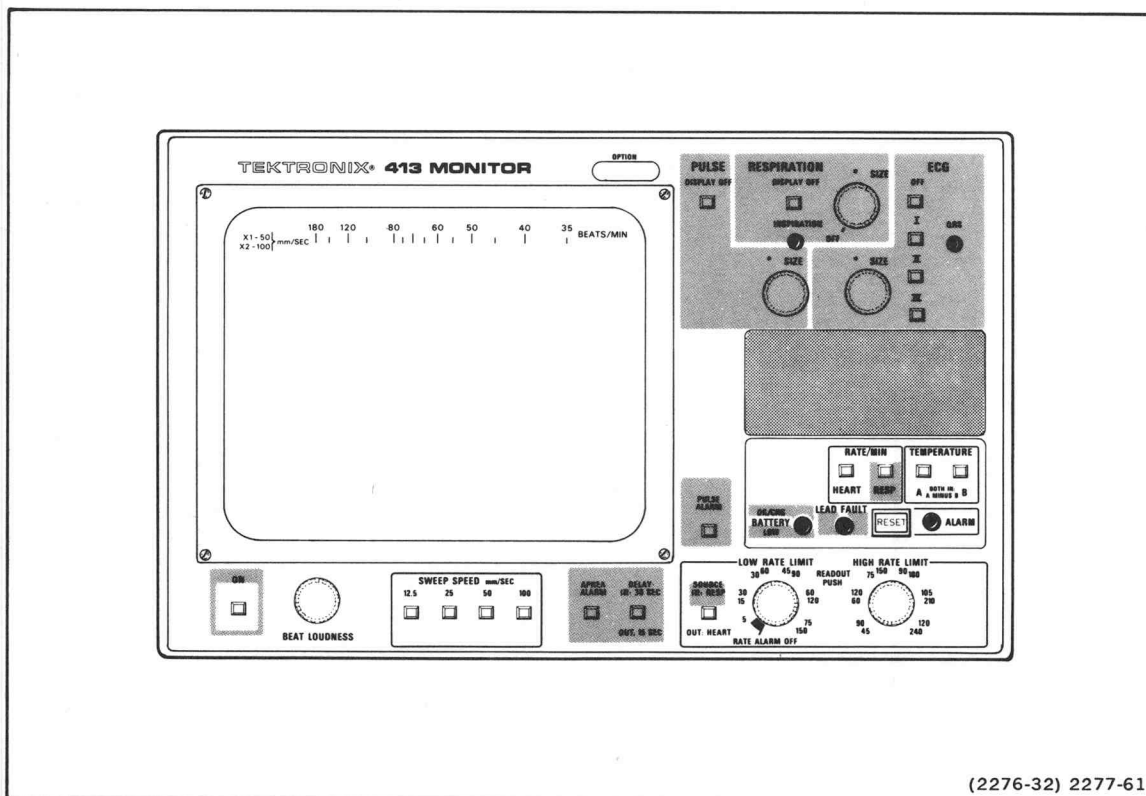
INTERACTION—Occurs between DVM Zero and DVM Cal adjustments. Repeat adjustments as needed.

16. GAGE FACTOR

Delete

17. TRACE ZERO AND VERTICAL SENSITIVITY

Delete



Option 20—Figure 1. 413 Option 20 front-panel controls and indicators.

OPTION 22

DESCRIPTION

This option expands the pressure scale ranges, and reduces the respiration rate alarm limits of the 413 Monitor to accommodate adult characteristics. Refer to the front-panel illustration in Option 22—Figure 1 (page 5). The three pressure scales, which include graticule graduations and pushbutton nomenclature are expanded to 0-50, 0-150, and 0-250 mmHg. The respiration low and high rate alarm limits (highlighted with an orange hue) are reduced; the LOW RATE and HIGH RATE LIMIT control ranges change to 5-25 and 15-40 respectively. Further, the pulse alarm threshold is changed to 10-15 mmHg. In general, the 413 Monitor circuitry has been optimized for use with adults.

A crt bezel is provided with this option for replacement of the existing bezel, should the plastic door be permanently removed.

All sections in this manual are applicable to the 413 Option 22, except as indicated in the following subsections.

SPECIFICATIONS

The Electrical Characteristics for the 413 Option 22 are the same as the Standard 413 (Section 1) except as shown in Option 22—Table 1.

OPTION 22—TABLE 1

Option 22 Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
ECG		
TRANSFER CHARACTERISTICS		
Bandwidth	0.2 Hz ($\pm 25\%$) to 50 Hz ($\pm 25\%$) at -3 db points.	
Trace Baseline Overshoot Following Pacer Signal	Less than 100 μV (referenced to input)	
QRS DETECTOR		
R Edge Timer		Initial value, 6 ± 1 ms. Self-adjusting between 6 and 10 ms.

OPTION 22—TABLE 1 (CONT.)
Option 22 Electrical Characteristics

Characteristics	Performance Requirements	Supplemental Information
RESPIRATION		
TRANSFER CHARACTERISTICS		
Bandwidth	0.05 Hz ($\pm 25\%$) to 4 Hz ($\pm 25\%$) at -3 db points.	
INSPIRATION DETECTOR		
Inspiration Phase Timing		150 ms ± 25 ms.
PRESSURE		
Ranges		
0-250	-50 to +300 mmHg.	
0-150	-30 to +180 mmHg.	
0-50	-10 to +60 mmHg.	
ALARMS		
LIMITS		
High	15-40 breath/min.	
Low	From less than 5 to 25 breaths/min.	
VIOLATIONS		
Pressure	Alarm is triggered when average pulsatile pressure (systolic minus diastolic) remains below 10 mmHg for 3-15 seconds.	Alarm will not be triggered when average pulsatile pressure exceeds 15 mmHg.
DIGITAL DISPLAY		
PRESSURE		
Ranges		
0-250	-50 to +350 mmHg	
0-150	-30 to +210 mmHg	
0-50	-10 to +70 mmHg.	

OPERATING INFORMATION

Option 22—Figure 1 (page 3) shows the front panel for the 413 Option 22. Other than changes in pressure ranges, rate limits, and pulse alarm threshold, all controls, connectors and indicators operate as in the Standard 413. See Section 2.

CALIBRATION

CHECK/ADJUST PROCEDURE

Perform the Check/Adjust Procedure in Section 5, making changes as follows:

B. ECG

B2. DC LEVEL

References to center of screen at 75 mmHg line is changed to **150 mmHg** line.

B6. QRS TIMING

C. **CHECK**—Interval to first positive-going edge at TP360 is **6 ms**, ± 1 ms.

C. RESPIRATION

C2. BALANCE

Reference to center of screen at 75 mmHg line are changed to **150 mmHg** line.

C4. CHEST IMPEDANCE RANGE CHECK

Reference to center of screen at 75 mmHg line is changed to **150 mmHg** line.

F. PRESSURE/PULSE

F1. GAGE FACTOR

Replace with the following:

a. Set:

PRESS 0-250In
 DISPLAY OFF (Resp)In (off)
 PULSE ALARMOut (off)
 MEANIn

b. Connect manometer to pressure transducer and pressure transducer to PRESSURE TRANSDUCER INPUT connector on rear panel. Connect test DVM between P2400-27 and TP1241 (ground 1), located on Conditioner board.

c. Press in ZERO control and adjust for test DVM reading of 0.0000, within 0.0200 V.

d. Apply **250 mmHg** pressure as indicated by manometer. Make sure pressure remains at **250 mmHg** and is not slowly diminishing.

e. **ADJUST**—Gage Factor (R865, Pressure/Pulse board) for test DVM reading of **2.5000**, ± 0.0100 V plus reading noted in step c.

f. Release manometer pressure.

g. **CHECK**—Test DVM reading noted in step e minus **2.5000**.

h. **INTERACTION**—Occurs between Pressure and Gage Factor adjustments. Repeat steps c through g as necessary until difference between 0 mmHg and 250 mmHg is **2.5000 V** within 0.0100 V.

i. Apply **250 mmHg** as indicated by manometer.

j. **CHECK**—413 digital display reads **250, ± 3 mmHg**.

k. Apply **150 mmHg** pressure as indicated by manometer.

l. **CHECK**—Digital display read **150, ± 3 mmHg**.

m. Apply **50 mmHg** pressure as indicated by manometer.

n. **CHECK**—Digital display reads **50, ± 3 mmHg**.

o. Set SYST/DIAST pushbutton in.

p. Apply **250 mmHg** pressure as indicated by manometer.

q. **CHECK**—Digital display reads **250, ± 3 mmHg**.

r. Release manometer pressure.

s. Remove test DVM.

F2. TRACE ZERO AND VERTICAL SENSITIVITY

e. Apply **250 mmHg** pressure as indicated by manometer.

f. **CHECK**—Trace should coincide with **250 mmHg** graticule line, ± 1 mm (0.1 div.).

F3. PRESSURE/PULSE OUTPUT

e. Apply pressure **250 mmHg** pressure as indicated by 413 digital display.

f. **CHECK**—Test DVM read **2.50 V, ± 50 mV**.

SHORT FORM ADJUSTMENT PROCEDURE

Perform the Short Form Adjustment Procedure as written in Section 5, ignoring all references to pressure and making changes as noted below.

16. GAGE FACTOR

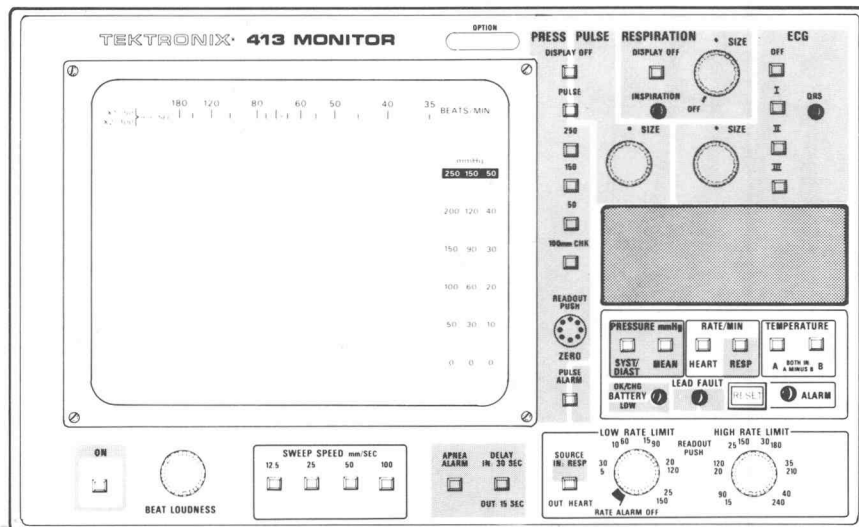
SET: PRESS 0-250.....In

SETUP—Connect manometer - - - - - . Apply **250 mmHg** pressure.

ADJUST—Gage Factor (R865) for test DVM reading of **2.5000, ± 0.01000 V**.

17. TRACE ZERO AND VERTICAL SENSITIVITY

SETUP—Apply **250 mmHg** pressure.



c2276-33

Option 22—Figure 1. 413 Option 22 front-panel controls and indicators.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICON	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
S0482	SONY CORPORATION		TOKYO, JAPAN
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01002	GENERAL ELECTRIC COMPANY, INDUSTRIAL AND POWER CAPACITOR PRODUCTS DEPARTMENT	JOHN STREET	HUDSON FALLS, NY 12839
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02660	BUNKER RAMO CORP., CONNECTOR DIVISION	2801 S 25TH AVENUE	BROADVIEW, IL 60153
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
05464	INDUSTRIAL ELECTRONIC ENGINEERING, INC.	7720 LEMONA AVENUE	VAN NUYS, CA 91405
06402	E.T.A. PRODUCTS COMPANY OF AMERICA	6284 NORTH CICERO AVENUE	CHICAGO, IL 60646
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
14099	SEMTECH CORP.	652 MITCHELL RD.	NEWBURY PARK, CA 91320
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
19396	ILLINOIS TOOL WORKS, INC. PAKTRON DIV.	900 FOLLIN LANE, SE	VIENNA, VA 22180
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
52536	BECKMAN INSTRUMENTS, INC., INFORMATION DISPLAYS OPERATION	350 N. HAYDEN ROAD	SCOTTSDALE, AZ 85257
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16 75
55292	LEDGO DIV., WILBRECHT ELECTRONICS, INC.	240 EAST PLATO BLVD.	ST. PAUL, MN 55107
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW- EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81073	GRAYHILL, INC.	561 HILLGROVE AVE., PO BOX 373	LA GRANGE, IL 60525
81312	WINCHESTER ELECTRONICS DIVISION		
82389	LITTON INDUSTRIES, INC.	MAIN ST. AND HILLSIDE AVE.	OAKVILLE, CT 06779
90201	SWITCHCRAFT, INC.	5555 N. ELSTON AVE.	CHICAGO, IL 60630
91637	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET	INDIANAPOLIS, IN 46206
94696	DALE ELECTRONICS, INC.	P. O. BOX 372	COLUMBUS, NE 68601
	MAGNECRAFT ELECTRIC COMPANY	P. O. BOX 609	CHICAGO, IL 60630
		5575 N LYNCH AVENUE	

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-5069-00		CKT BOARD ASSY:ECG (STANDARD AND OPTION 20 ONLY)	80009	670-5069-00
A1	670-5304-00		CKT BOARD ASSY:ECG (OPTION 22 ONLY)	80009	670-5304-00
A2	670-5073-00		CKT BOARD ASSY:RESPIRATION (STANDARD AND OPTION 20 ONLY)	80009	670-5073-00
A2	670-5309-00		CKT BOARD ASSY:RESPIRATION (OPTION 22 ONLY)	80009	670-5309-00
A3	670-5070-00		CKT BOARD ASSY:PRESSURE/PULSE (STANDARD ONLY)	80009	670-5070-00
A3	670-5305-00		CKT BOARD ASSY:PRESSURE/PULSE (OPTION 22 ONLY)	80009	670-5305-00
A3	670-5306-00		CKT BOARD ASSY:PULSE (OPTION 20 ONLY)	80009	670-5306-00
A4	670-5072-00		CKT BOARD ASSY:DVM	80009	670-5072-00
A5	670-5071-00		CKT BOARD ASSY:CONDITIONER (STANDARD ONLY)	80009	670-5071-00
A5	670-5307-00		CKT BOARD ASSY:CONDITIONER (OPTION 20 ONLY)	80009	670-5307-00
A5	670-5308-00		CKT BOARD ASSY:CONDITIONER (OPTION 22 ONLY)	80009	670-5308-00
A6	670-5068-00		CKT BOARD ASSY:MOTHER	80009	670-5068-00
A7	670-5074-00		CKT BOARD ASSY:HIGH VOLTAGE	80009	670-5074-00
A8	670-5076-00		CKT BOARD ASSY:DISPLAY	80009	670-5076-00
A9	670-5075-00		CKT BOARD ASSY:SWEEP SWITCH	80009	670-5075-00
A10	670-5077-00		CKT BOARD ASSY:READOUT SWITCH (STANDARD AND OPTION 22 ONLY)	80009	670-5077-00
A10	670-5310-00		CKT BOARD ASSY:READOUT SWITCH (OPTION 20 ONLY)	80009	670-5310-00
A12	670-5245-00		CKT BOARD ASSY:B FLASH B RATE CONVERTER (OPTION 5 ONLY)	80009	670-5245-00
B1982(4)	-----		BATTERY, STORAGE:1.2V (FURNISHED AS A UNIT W/119-0443-01)		
C102	290-0534-00		CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C103	290-0534-00		CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C112	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C113	290-0534-00		CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C116	283-0032-00		CAP.,FXD,CER DI:470PF,5%,500V	72982	083108525E00471J
C131	283-0128-00		CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
C137	283-0175-00		CAP.,FXD,CER DI:10PF,5%,200V	72982	8101B210C0G0100J
C141	283-0128-00		CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
C147	283-0110-00		CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C2428
C161	283-0128-00		CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
C162	283-0594-00		CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C183	283-0238-00		CAP.,FXD,CER DI:0.01UF,10%,50V	72982	8121N075X7R0103K
C192	283-0268-00		CAP.,FXD,CER DI:0.015UF,10%,50V	72982	8121N083X7R0153K
C199	283-0268-00		CAP.,FXD,CER DI:0.015UF,10%,50V	72982	8121N083X7R0153K
C202	285-0809-00		CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C230	283-0341-00		CAP.,FXD,CER DI:0.047UF,10%,100V (STANDARD AND OPTION 20 ONLY)	72982	8121N153X7R0473K
C238	283-0212-00		CAP.,FXD,CER DI:2UF,20%,50V	72982	8141N064Z5U205M
C291	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C292	290-0512-00		CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C297	290-0536-00		CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C298	290-0512-00		CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C306	283-0128-00		CAP.,FXD,CER DI:100PF,5%,500V	72982	871-536T2H101J
C309	283-0339-00		CAP.,FXD,CER DI:0.22UF,10%,50V	72982	8131N075W5R224K
C312	283-0100-00		CAP.,FXD,CER DI:0.0047UF,10%,200V	56289	273C3

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C321	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V	56289	196D226X0015KA1
C322	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V	56289	196D226X0015KA1
C327	283-0177-00			CAP., FXD, CER DI: 1UF, +80-20%, 25V	72982	8131N039 E 105Z
C343	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C356	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C363	285-0598-00			CAP., FXD, PLSTC: 0.01UF, 5%, 100V	01002	61F10AC103
C371	285-1076-00			CAP., FXD, PLSTC: 0.2UF, 5%, 100V	14752	230B1B204J
C372	283-0111-00	XB020292		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C373	290-0523-00			CAP., FXD, ELCTLT: 2.2UF, 20%, 20V	56289	196D225X0020HA1
C378	283-0339-00			CAP., FXD, CER DI: 0.22UF, 10%, 50V	72982	8131N075W5R224K
C379	283-0103-00			CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C381	283-0177-00			CAP., FXD, CER DI: 1UF, +80-20%, 25V	72982	8131N039 E 105Z
C384	283-0238-00			CAP., FXD, CER DI: 0.01UF, 10%, 50V	72982	8121N075X7R0103K
C387	283-0190-00			CAP., FXD, CER DI: 0.47UF, 5%, 50V	72982	8141N077X7R0474J
C389	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C407	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C409	283-0594-00			CAP., FXD, MICA D: 0.001UF, 1%, 100V	00853	D151F102F0
C412	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C413	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C414	281-0504-00			CAP., FXD, CER DI: 10PF, +/-1PF, 500V	72982	301-055C0G0100F
C423	283-0060-00			CAP., FXD, CER DI: 100PF, 5%, 200V	72982	855-535U2J101J
C424	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C439	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C441	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C449	285-0919-00	B010100	B019999	CAP., FXD, PLSTC: 0.22UF, 10%, 100V	56289	LP66A1B224K002
C449	285-1097-00	B020000		CAP., FXD, PLSTC: 0.47UF, 10%, 100V	14752	230B1B474K
C461	285-1096-00			CAP., FXD, PLSTC: 1UF, 10%, 100V	14752	230B1B105K
C465	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C467	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C476	283-0212-00			CAP., FXD, CER DI: 2UF, 20%, 50V	72982	8141N064Z5U205M
C491	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C492	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V	56289	196D226X0015KA1
C497	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C498	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V	56289	196D226X0015KA1
C506	283-0060-00			CAP., FXD, CER DI: 100PF, 5%, 200V	72982	855-535U2J101J
C508	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 20 ONLY)	90201	TDC106M025FL
C508	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V (OPTION 22 ONLY)	56289	196D226X0015KA1
C509	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 20 ONLY)	90201	TDC106M025FL
C509	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V (OPTION 22 ONLY)	56289	196D226X0015KA1
C511	283-0060-00			CAP., FXD, CER DI: 100PF, 5%, 200V	72982	855-535U2J101J
C512	283-0111-00	B010100	B020291	CAP., FXD, CER DI: 0.1UF, 20%, 50V (STANDARD AND OPTION 20 ONLY)	72982	8121-N088Z5U104M
C512	283-0239-00	B020292		CAP., FXD, CER DI: 0.022UF, 10%, 50V (STANDARD AND OPTION 20 ONLY)	72982	8121N083X7R0223K
C512	283-0111-00	B010100	B020291	CAP., FXD, CER DI: 0.1UF, 20%, 50V (OPTION 22 ONLY)	72982	8121-N088Z5U104M
C512	283-0341-00	B020292		CAP., FXD, CER DI: 0.047UF, 10%, 100V (OPTION 22 ONLY)	72982	8121N153X7R0473K
C521	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C522	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C527	283-0177-00			CAP., FXD, CER DI: 1UF, +80-20%, 25V	72982	8131N039 E 105Z
C543	290-0719-00			CAP., FXD, ELCTLT: 47UF, 20%, 25V (STANDARD AND OPTION 20 ONLY)	56289	196D476X0025TE3
C543	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V (OPTION 22 ONLY)	56289	196D107X0020TE3
C544	290-0527-00			CAP., FXD, ELCTLT: 15UF, 20%, 20V (OPTION 22 ONLY)	90201	TDC156M020FL

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
C567	285-1076-00			CAP., FXD, PLSTC: 0.2UF, 5%, 100V	14752	230B1B204J
C571	285-1076-00			CAP., FXD, PLSTC: 0.2UF, 5%, 100V	14752	230B1B204J
C572	283-0111-00	XB020292		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C574	290-0525-00			CAP., FXD, ELCTLT: 4.7UF, 20%, 50V (STANDARD AND OPTION 20 ONLY)	56289	196D475X0050KA1
C579	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C592	283-0190-00	XB031200		CAP., FXD, CER DI: 0.47UF, 5%, 50V	72982	8141N077X7R0474J
C606	283-0211-00			CAP., FXD, CER DI: 0.1UF, 10%, 200V	72982	8141N210X7R0104K
C607	283-0211-00			CAP., FXD, CER DI: 0.1UF, 10%, 200V	72982	8141N210X7R0104K
C608	283-0211-00			CAP., FXD, CER DI: 0.1UF, 10%, 200V	72982	8141N210X7R0104K
C612	285-1069-00			CAP., FXD, PLSTC: 0.047UF, 200V	14752	C2319
C615	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V	72982	301-000U2M0101M
C616	290-0719-00	B010100	B020291	CAP., FXD, ELCTLT: 47UF, 20%, 25V (STANDARD AND OPTION 20 ONLY)	56289	196D476X0025TE3
C616	290-0719-01	B020292		CAP., FXD, ELCTLT: 47UF, 20%, 25V (STANDARD AND OPTION 20 ONLY)	80009	290-0719-01
C618	285-1069-00			CAP., FXD, PLSTC: 0.047UF, 200V	14752	C2319
C621	285-1069-00			CAP., FXD, PLSTC: 0.047UF, 200V	14752	C2319
C639	285-1101-00			CAP., FXD, PLSTC: 0.022UF, 10%, 200V	19396	223K02PT485
C666	290-0441-00			CAP., FXD, ELCTLT: 20UF, 10%, 10V	56289	109D206X9010C2
C667	281-0543-00			CAP., FXD, CER DI: 270PF, 10%, 500V	72982	301055X5P271K
C702	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C767	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0020TE3
C769	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C773	290-0719-00			CAP., FXD, ELCTLT: 47UF, 20%, 25V (STANDARD AND OPTION 22 ONLY)	56289	196D476X0025TE3
C773	290-0527-00			CAP., FXD, ELCTLT: 15UF, 20%, 20V (OPTION 20 ONLY)	90201	TDC156M020FL
C787	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0020TE3
C789	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C794	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C796	283-0067-00			CAP., FXD, CER DI: 0.001UF, 10%, 200V (STANDARD AND OPTION 22 ONLY)	72982	835-515B102K
C797	283-0067-00			CAP., FXD, CER DI: 0.001UF, 10%, 200V (STANDARD AND OPTION 22 ONLY)	72982	835-515B102K
C806	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V (STANDARD AND OPTION 22 ONLY)	56289	196D105X0035HA1
C807	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V (STANDARD AND OPTION 22 ONLY)	56289	196D105X0035HA1
C808	283-0167-00			CAP., FXD, CER DI: 0.1UF, 10%, 100V	72982	8131N145X5R0104K
C809	283-0167-00			CAP., FXD, CER DI: 0.1UF, 10%, 100V	72982	8131N145X5R0104K
C812	283-0111-00	XB020292		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C813	283-0111-00	XB020292		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C821	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C826	281-0605-00			CAP., FXD, CER DI: 200PF, 10%, 500V (STANDARD AND OPTION 22 ONLY)	04222	7001-1375
C827	283-0194-00			CAP., FXD, CER DI: 4.7UF, 20%, 50V (STANDARD AND OPTION 22 ONLY)	72982	8151N057Z5U0475M
C831	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C836	281-0605-00			CAP., FXD, CER DI: 200PF, 10%, 500V (STANDARD AND OPTION 22 ONLY)	04222	7001-1375
C844	283-0059-00			CAP., FXD, CER DI: 1UF, +80-20%, 25V (STANDARD AND OPTION 22 ONLY)	72982	8131N031Z5U0105Z

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
C862	281-0523-00			CAP., FXD, CER DI: 100PF, +/-20PF, 500V (STANDARD AND OPTION 22 ONLY)	72982	301-000U2M0101M
C871	283-0059-00			CAP., FXD, CER DI: 1UF, +80-20%, 25V (STANDARD AND OPTION 22 ONLY)	72982	8131N031Z5U0105Z
C874	283-0203-00			CAP., FXD, CER DI: 0.47UF, 20%, 50V (STANDARD AND OPTION 22 ONLY)	72982	8131N075 E474M
C876	283-0167-00			CAP., FXD, CER DI: 0.1UF, 10%, 100V (STANDARD AND OPTION 22 ONLY)	72982	8131N145X5R0104K
C877	283-0167-00			CAP., FXD, CER DI: 0.1UF, 10%, 100V (STANDARD AND OPTION 22 ONLY)	72982	8131N145X5R0104K
C878	283-0167-00			CAP., FXD, CER DI: 0.1UF, 10%, 100V (STANDARD AND OPTION 22 ONLY)	72982	8131N145X5R0104K
C911	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C919	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C936	283-0065-00			CAP., FXD, CER DI: 0.001UF, 5%, 100V	72982	805-518-Z5D0102J
C939	285-1096-00			CAP., FXD, PLSTC: 1UF, 10%, 100V	14752	230B1B105K
C956	283-0107-00	XB031270		CAP., FXD, CER DI: 51PF, 5%, 200V	72982	8121B232C0G0510J
C959	283-0107-00	XB031270		CAP., FXD, CER DI: 51PF, 5%, 200V	72982	8121B232C0G0510J
C962	283-0107-00	XB031270		CAP., FXD, CER DI: 51PF, 5%, 200V	72982	8121B232C0G0510J
C965	283-0107-00	XB031270		CAP., FXD, CER DI: 51PF, 5%, 200V	72982	8121B232C0G0510J
C1003	290-0512-00			CAP., FXD, ELCTLT: 22UF, 20%, 15V	56289	196D226X0015KA1
C1006	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M0 5FL
C1011	283-0003-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
C1012	283-0057-00			CAP., FXD, CER DI: 0.1UF, +80-20%, 200V	56289	274C10
C1013	283-0057-00			CAP., FXD, CER DI: 0.1UF, +80-20%, 200V	56289	274C10
C1016	283-0003-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 150V	72982	855-558Z5U-103Z
C1032	283-0660-00			CAP., FXD, MICA D: 510PF, 2%, 500V	00853	D155F511G0
C1039	285-0598-00			CAP., FXD, PLSTC: 0.01UF, 5%, 100V	01002	61F10AC103
C1126	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C1151	290-0580-00			CAP., FXD, ELCTLT: 0.27UF, 20%, 50V	56289	196D274X0050HA1
C1179	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1207	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1209	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 22 ONLY)	90201	TDC106M025FL
C1212	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1213	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 22 ONLY)	90201	TDC106M025FL
C1231	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1233	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1236	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1237	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 22 ONLY)	90201	TDC106M025FL
C1241	290-0534-00			CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C1242	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1246	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1246	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1251	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1253	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1256	290-0722-00			CAP., FXD, ELCTLT: 100UF, 20%, 10V (STANDARD AND OPTION 22 ONLY)	56289	196D107X0010PE3
C1257	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V (STANDARD AND OPTION 22 ONLY)	90201	TDC106M025FL

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
C1312	290-0572-00		CAP., FXD, ELCTLT: 0.1UF, 20%, 50V	56289	196D104X0050HA1
C1316	285-1097-00		CAP., FXD, PLSTC: 0.47UF, 10%, 100V	14752	230B1B474K
C1326	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1331	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1334	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1336	290-0722-00		CAP., FXD, ELCTLT: 100UF, 20%, 10V	56289	196D107X0010PE3
C1337	290-0536-00		CAP., FXD, ELCTLT: 33UF, 20%, 25V	90201	TDC106M025FL
C1342	290-0572-00		CAP., FXD, ELCTLT: 0.1UF, 20%, 50V	56289	196D104X0050HA1
C1346	285-1096-00		CAP., FXD, PLSTC: 1UF, 10%, 100V	14752	230B1B105K
C1356	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1361	290-0535-00		CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C1364	290-0530-00		CAP., FXD, ELCTLT: 68UF, 20%, 6V	90201	TDC686M006NLF
C1366	290-0724-00		CAP., FXD, ELCTLT: 330UF, 20%, 6V	90201	TDC337M006WSH
C1367	290-0535-00		CAP., FXD, ELCTLT: 33UF, 20%, 10V	56289	196D336X0010KA1
C1404	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1437	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1464	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1522	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1543	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1552	290-0722-00		CAP., FXD, ELCTLT: 100UF, 20%, 10V	56289	196D107X0010PE3
C1562	283-0178-00		CAP., FXD, CER DI: 0.1UF, +80-20%, 100V	72982	8131N145651 104Z
C1563	283-0178-00		CAP., FXD, CER DI: 0.1UF, +80-20%, 100V	72982	8131N145651 104Z
C1564	283-0178-00		CAP., FXD, CER DI: 0.1UF, +80-20%, 100V	72982	8131N145651 104Z
C1571	290-0534-00		CAP., FXD, ELCTLT: 1UF, 20%, 35V	56289	196D105X0035HA1
C1581	283-0178-00		CAP., FXD, CER DI: 0.1UF, +80-20%, 100V	72982	8131N145651 104Z
C1591	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1601	290-0536-00	XB030850	CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1602	290-0536-00	XB030850	CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1603	290-0536-00	XB030850	CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1604	290-0536-00	XB030850	CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1619	283-0655-00		CAP., FXD, MICA D: 0.0033UF, 1%, 500V	00853	D195F332F0
C1636	281-0786-00		CAP., FXD, CER DI: 150PF, 10%, 100V	72982	8035D2AADX5P151K
C1637	281-0788-00		CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C1641	281-0770-00	B010100 B020291	CAP., FXD, CER DI: 0.001UF, 20%, 100V	72982	8035D9AADX5R102M
C1641	281-0812-00	B020292	CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	8035D9AADX7R102K
C1648	281-0788-00		CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C1656	281-0770-00	B010100 B020291	CAP., FXD, CER DI: 0.001UF, 20%, 100V	72982	8035D9AADX5R102M
C1656	281-0812-00	B020292	CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	8035D9AADX7R102K
C1684	281-0770-00	B010100 B020291	CAP., FXD, CER DI: 0.001UF, 20%, 100V	72982	8035D9AADX5R102M
C1684	281-0812-00	B020292 B030849X	CAP., FXD, CER DI: 1000PF, 10%, 100V	72982	8035D9AADX7R102K
C1706	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C1732	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C1734	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C1751	290-0721-00	B010100 B020291	CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C1751	290-0722-00	B020292	CAP., FXD, ELCTLT: 100UF, 20%, 10V	56289	196D107X0010PE3
C1771	283-0111-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C1777	281-0763-00		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C1794	281-0763-00		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C1797	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1837	283-0111-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C1911	290-0508-00		CAP., FXD, ELCTLT: 18,000UF, +100-10%, 15V	56289	68D10444
C1916	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1933	290-0721-00	B010100 B020291	CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C1933	290-0722-00	B020292	CAP., FXD, ELCTLT: 100UF, 20%, 10V	56289	196D107X0010PE3
C1939	283-0111-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C1959	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1961	290-0536-00		CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C1969	283-0198-00		CAP., FXD, CER DI: 0.22UF, 20%, 50V	72982	8121N083Z5U0224M
C1990	283-0111-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1994	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C2016	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C2041	290-0721-00	B010100	B020291	CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C2041	290-0722-00	B020292		CAP., FXD, ELCTLT: 100UF, 20%, 10V	56289	196D107X0010PE3
C2053	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C2064	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C2073	290-0809-00			CAP., FXD, ELCTLT: 6.8UF, 20%, 50V	56289	196D685X0050PE4
C2077	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C2081	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2082	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2083	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2087	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2088	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2089	290-0726-00			CAP., FXD, ELCTLT: 220UF, 20%, 10V	56289	196D227X0010TE3
C2093	290-0721-00			CAP., FXD, ELCTLT: 100UF, 20%, 20V	56289	196D107X0020TE3
C2097	290-0809-00			CAP., FXD, ELCTLT: 6.8UF, 20%, 50V	56289	196D685X0050PE4
C2121	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2122	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2123	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2124	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2125	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2126	283-0280-00			CAP., FXD, CER DI: 2200PF, 10%, 2000V	56289	562CBA202EH222KA
C2146	283-0111-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C2161	283-0006-00			CAP., FXD, CER DI: 0.02UF, +80-20%, 500V	72982	0841545Z5V00203Z
C2163	283-0006-00			CAP., FXD, CER DI: 0.02UF, +80-20%, 500V	72982	0841545Z5V00203Z
C2216	283-0000-00			CAP., FXD, CER DI: 0.001UF, +100-0%, 500V	72982	831-516E102P
C2236	283-0193-00			CAP., FXD, CER DI: 510PF, 2%, 100V	72982	8121N130C0G0511G
C2252	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C2253	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C2254	290-0536-00			CAP., FXD, ELCTLT: 10UF, 20%, 25V	90201	TDC106M025FL
C2257	281-0549-00			CAP., FXD, CER DI: 68PF, 10%, 500V	72982	301-000U2J0680K
CB1906	260-1878-00			CIRCUIT BREAKER: SPST, 0.5A, 250V	06402	41-06-P30
CB1907	260-1877-00			CIRCUIT BREAKER: SPST, 0.3A, 250V	06402	41-06-P30
CR106	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR107	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR108	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR109	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR135	152-0246-00			SEMICOND DEVICE: SILICON, 400PIV, 200MA	80009	152-0246-00
CR136	152-0246-00			SEMICOND DEVICE: SILICON, 400PIV, 200MA	80009	152-0246-00
CR154	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR165	152-0246-00			SEMICOND DEVICE: SILICON, 400PIV, 200MA	80009	152-0246-00
CR166	152-0246-00			SEMICOND DEVICE: SILICON, 400PIV, 200MA	80009	152-0246-00
CR223	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR224	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR237	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR244	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR246	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR249	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR252	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR257	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR258	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02
CR316	152-0141-02			SEMICOND DEVICE: SILICON, 30V, 50NA	80009	152-0141-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR317	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR326	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR327	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR329	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR343	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR351	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR352	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR353	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR354	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR356	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR373	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR389	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR391	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR411	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR427	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR428	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR476	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR481	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR482	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR484	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR485	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR486	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR516	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR517	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR526	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR527	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR529	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR543	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR551	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR552	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR553	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR554	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR574	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR579	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR581	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR611	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR612	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR616	152-0141-02	B010100	B020291	SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR616	152-0246-00	B020292		SEMICON D DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR626	152-0141-02	B010100	B020291	SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR626	152-0246-00	B020292		SEMICON D DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR627	152-0141-02	B010100	B020291	SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR627	152-0246-00	B020292		SEMICON D DEVICE:SILICON,400PIV,200MA	80009	152-0246-00
CR628	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR629	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR643	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR653	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR663	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR664	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR667	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR686	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR691	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR692	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR693	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR702	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR717	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR727	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR728	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR752	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR753	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
CR754	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR765	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR766	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR767	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR769	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR772	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR785	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR786	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR787	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR789	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR792	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR796	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR797	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR822	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR823	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR832	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR833	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR842	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR843	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR916	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR930	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR952	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR982	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1003	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1011	152-0107-00		SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR1012	152-0107-00		SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR1013	152-0107-00		SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR1016	152-0107-00		SEMICON D DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR1061	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1062	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1065	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1067	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1069	152-0061-00		SEMICON D DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR1122	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR1124	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		
CR1134	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1136	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1137	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1138	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
	-----		(STANDARD AND OPTION 22 ONLY)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
CR1151	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1162	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1163	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1171	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1172	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1173	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1203	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA (STANDARD AND OPTION 22 ONLY)	80009	152-0141-02
CR1204	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA (STANDARD AND OPTION 22 ONLY)	80009	152-0141-02
CR1244	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA (STANDARD AND OPTION 22 ONLY)	80009	152-0141-02
CR1248	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA (STANDARD AND OPTION 22 ONLY)	80009	152-0141-02
CR1321	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1322	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1351	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1352	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1522	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1541	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1542	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1552	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1571	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1577	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1579	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1667	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR1677	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR1683	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR1684	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR1714	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1717	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1718	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1719	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1725	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1726	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1727	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1729	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1746	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1747	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1748	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1749	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1751	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1776	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1793	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1812	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1910	152-0668-00		SEMICON D DEVICE:RECT BRIDGE,SI,200V,6A	80009	152-0668-00
CR1911	152-0668-00		SEMICON D DEVICE:RECT BRIDGE,SI,200V,6A	80009	152-0668-00
CR1916	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR1926	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1945	152-0423-00		SEMICON D DEVICE:SILICON,400V,3A	04713	1N5000
CR1987	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR1996	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2041	152-0141-02		SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2063	152-0075-00		SEMICON D DEVICE:GE,25V,40MA	80009	152-0075-00
CR2071	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2072	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2075	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2076	152-0107-03		SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2079	152-0066-01	B010100 B020399	SEMICON D DEVICE:SILICON,400V,1A	80009	152-0066-01
CR2079	152-0198-02	B020400	SEMICON D DEVICE:SILICON,200V,3A	14099	3SM2

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
CR2080	152-0066-01	B010100	B020399	SEMICON D DEVICE:SILICON,400V,1A	80009	152-0066-01
CR2080	152-0198-02	B020400		SEMICON D DEVICE:SILICON,200V,3A	14099	3SM2
CR2085	152-0066-01	B010100	B020399	SEMICON D DEVICE:SILICON,400V,1A	80009	152-0066-01
CR2085	152-0198-02	B020400		SEMICON D DEVICE:SILICON,200V,3A	14099	3SM2
CR2086	152-0066-01	B010100	B020399	SEMICON D DEVICE:SILICON,400V,1A	80009	152-0066-01
CR2086	152-0198-02	B020400		SEMICON D DEVICE:SILICON,200V,3A	14099	3SM2
CR2091	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2092	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2095	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2096	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2121	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2122	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2123	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2124	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2125	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2126	152-0170-00			SEMICON D DEVICE:SILICON,1500V,10UA	80009	152-0170-00
CR2143	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2145	152-0066-00	XB030850		SEMICON D DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR2146	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2151	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2152	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2153	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2154	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2156	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA	80009	152-0141-02
CR2161	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2163	152-0107-03			SEMICON D DEVICE:SILICON,375V,400MA,SEL	80009	152-0107-03
CR2212	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA (OPTION 5 ONLY)	80009	152-0141-02
CR2232	152-0141-02			SEMICON D DEVICE:SILICON,30V,50NA (OPTION 5 ONLY)	80009	152-0141-02
DS131	150-0173-00			LAMP,GLOW:LKG LESS THAN 1 NA	08806	C2A-T
DS141	150-0173-00			LAMP,GLOW:LKG LESS THAN 1 NA	08806	C2A-T
DS161	150-0173-00			LAMP,GLOW:LKG LESS THAN 1 NA	08806	C2A-T
DS470	150-1033-00			LT EMITTING DIO:YELLOW,585NM,40MA MAX	50434	5082-4584
DS1598	150-0123-01			LAMP,CARTRIDGE:14V,0.023A,YELLOW LENS	55292	71326-06
DS1648	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
DS1649	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
DS1725	150-1029-00			LT EMITTING DIO:GREEN,565NM,35A	53184	XC209G
DS1727	150-1031-00			LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
DS2039	150-1049-00			LT EMITTING DIO:RED/GREEN	05464	232 RG
F1981	159-0152-00	XB030800		FUSE,WIRE LEAD:5A,125V,FAST BLOW	75915	275-005
F1982	159-0045-00			FUSE,CARTRIDGE:20A,250V,7 SEC (FURNISHED AS A UNIT WITH 119-0443-01)	71400	ABC 20
F1983	159-0045-00			FUSE,CARTRIDGE:20A,250V,7 SEC (FURNISHED AS A UNIT WITH 119-0443-01)	71400	ABC 20
J130	131-1378-00	B010100	B030789	CONNECTOR,RCPT,:5 CONTACT	02660	7-8934
J130	131-1378-01	B030790		CONNECTOR,RCPT:5 CONTACT	80009	131-1378-01
J606	131-1376-00			CONNECTOR,RCPT,:4 CONTACT	81312	M43-LRN
J626	131-1376-00			CONNECTOR,RCPT,:4 CONTACT	81312	M43-LRN
J816	131-1375-00			CONN,RCPT,ELEC:FLANGE MT,6 CONT,FEMALE	02660	MS3102A
J1401	131-1863-00			JACK,TELEPHONE:STD 0.25,5 COND DBL-CL CKT	82389	11413
J1461	131-1863-00			JACK,TELEPHONE:STD 0.25,5 COND DBL-CL CKT	82389	11413
J1596	131-1862-00			JACK,TELEPHONE:	82389	112B
J1597	131-1862-00			JACK,TELEPHONE:	82389	112B
J1598	131-1862-00			JACK,TELEPHONE:	82389	112B
K1913	148-0112-00			RELAY,ARMATURE:SPDT,6VDC,5A	94696	W65RPCX-1
L162	108-0888-00			COIL,RF:10MH	80009	108-0888-00
L409	108-0888-00			COIL,RF:10MH	80009	108-0888-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
L1690	119-0950-00 -----		COIL, TUBE DEFL: CRT YOKE (FURNISHED AS A UNIT W/RT1690)	80009	119-0950-00
LS1759	119-0716-01		LOUDSPEAKER, PM: W/CABLE	80009	119-0716-01
Q116	151-0302-00		TRANSISTOR: SILICON, NPN	80009	151-0302-00
Q117	151-0302-00		TRANSISTOR: SILICON, NPN	80009	151-0302-00
Q139A, B	151-1049-00		TRANSISTOR: SILICON, JFE, N-CHANNEL, DUAL	80009	151-1049-00
Q154	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q207A, B	151-1049-00		TRANSISTOR: SILICON, JFE, N-CHANNEL, DUAL	80009	151-1049-00
Q236	151-1004-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	80009	151-1004-00
Q252	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q255	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q291	151-0302-00		TRANSISTOR: SILICON, NPN	80009	151-0302-00
Q297	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
Q333	151-1004-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	80009	151-1004-00
Q334	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q341	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q360	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q363	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q367	151-0342-00		TRANSISTOR: SILICON, PNP	80009	151-0342-00
Q373	151-0342-00		TRANSISTOR: SILICON, PNP	80009	151-0342-00
Q381	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q384	151-0508-00		TRANSISTOR: SILICON, NPN, PROGRAMMABLE	03508	2N6027
Q392	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q406	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q461A, B	151-1049-00		TRANSISTOR: SILICON, JFE, N-CHANNEL, DUAL	80009	151-1049-00
Q474	151-1004-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	80009	151-1004-00
Q491	151-0302-00		TRANSISTOR: SILICON, NPN	80009	151-0302-00
Q497	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
Q533	151-1004-00		TRANSISTOR: SILICON, JFE, N-CHANNEL	80009	151-1004-00
Q534	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q541	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q560	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q563	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q567	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q574	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q582	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q666	151-0224-00		TRANSISTOR: SILICON, NPN	80009	151-0224-00
Q767	151-0224-00		TRANSISTOR: SILICON, NPN	80009	151-0224-00
Q767	-----		(STANDARD AND OPTION 22 ONLY)		
Q787	151-0188-00 -----		TRANSISTOR: SILICON, PNP (STANDARD AND OPTION 22 ONLY)	80009	151-0188-00
Q844	151-0224-00 -----		TRANSISTOR: SILICON, NPN (STANDARD AND OPTION 22 ONLY)	80009	151-0224-00
Q955	151-0444-00		TRANSISTOR: SILICON, NPN	80009	151-0444-00
Q956	151-0443-00		TRANSISTOR: SILICON, PNP	80009	151-0443-00
Q958	151-0444-00		TRANSISTOR: SILICON, NPN	80009	151-0444-00
Q959	151-0443-00		TRANSISTOR: SILICON, PNP	80009	151-0443-00
Q961	151-0444-00		TRANSISTOR: SILICON, NPN	80009	151-0444-00
Q962	151-0443-00		TRANSISTOR: SILICON, PNP	80009	151-0443-00
Q964	151-0444-00		TRANSISTOR: SILICON, NPN	80009	151-0444-00
Q965	151-0443-00		TRANSISTOR: SILICON, PNP	80009	151-0443-00
Q979	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00
Q982	151-0347-00		TRANSISTOR: SILICON, NPN	80009	151-0347-00
Q990	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q992	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q1003	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
Q1031	151-0188-00		TRANSISTOR: SILICON, PNP	80009	151-0188-00
Q1032	151-0190-00		TRANSISTOR: SILICON, NPN	80009	151-0190-00

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1033	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1043	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1061	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1062	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1065	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1067	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1069	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1152	151-0508-00			TRANSISTOR:SILICON,NPN,PROGRAMMABLE	03508	2N6027
Q1551	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q1571	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1576	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1577	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1594	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q1613	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1617	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1621	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1642	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1656	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1657	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1662	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1663	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1664	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1666	151-0350-00			TRANSISTOR:SILICON,PNP	80009	151-0350-00
Q1667	151-0407-00			TRANSISTOR:SILICON,NPN	80009	151-0407-00
Q1672	151-0350-00			TRANSISTOR:SILICON,PNP	80009	151-0350-00
Q1673	151-0350-00			TRANSISTOR:SILICON,PNP	80009	151-0350-00
Q1674	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q1676	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q1677	151-0406-00			TRANSISTOR:SILICON,PNP	80009	151-0406-00
Q1713	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1714	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1758	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1759	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1776	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1793	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1812	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1842	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1843	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1852	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1853	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1936	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1939	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q1944	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q1945	151-0373-00			TRANSISTOR:SILICON,PNP	80009	151-0373-00
Q1966	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1967	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1972	151-0477-00			TRANSISTOR:SILICON,NPN	01295	TIP35A
Q1973	151-0477-00			TRANSISTOR:SILICON,NPN	01295	TIP35A
Q1993	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q2021	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q2029	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q2049	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2051	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2053	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2142	151-0350-00			TRANSISTOR:SILICON,PNP	80009	151-0350-00
Q2146	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q2212	151-0188-00			TRANSISTOR:SILICON,PNP (OPTION 5 ONLY)	80009	151-0188-00
Q2232	151-0188-00			TRANSISTOR:SILICON,PNP (OPTION 5 ONLY)	80009	151-0188-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R112	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R117	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R131	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R135	314-0011-00		RES., FXD, FILM: 10G OHM, 30%, 0.5W	01121	EBH1093
R136	321-0510-00		RES., FXD, FILM: 2M OHM, 1%, 0.125W	91637	HFF188G20003F
R139	321-0306-00		RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R146	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R147	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R151	321-0378-00		RES., FXD, FILM: 84.5K OHM, 1%, 0.125W	91637	MFF1816G84501F
R152	322-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.25W	75042	CEBT0-2001F
R153	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R156	321-0318-00		RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R157	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R158	321-0378-00		RES., FXD, FILM: 84.5K OHM, 1%, 0.125W	91637	MFF1816G84501F
R162	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R165	314-0011-00		RES., FXD, FILM: 10G OHM, 30%, 0.5W	01121	EBH1093
R166	321-0510-00		RES., FXD, FILM: 2M OHM, 1%, 0.125W	91637	HFF188G20003F
R169	321-0306-00		RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R179	323-0085-00		RES., FXD, FILM: 75 OHM, 1%, 0.50W	91637	MFF1226G75R00F
R180	311-1244-00		RES., VAR, NONWIR: 100 OHM, 10%, 0.50W	32997	3386X-T07-101
R181	322-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.25W	75042	CEBT0-1001F
R183	315-0163-00		RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R186	321-0239-00		RES., FXD, FILM: 3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
R187	321-0274-00		RES., FXD, FILM: 6.98K OHM, 1%, 0.125W	91637	MFF1816G69800F
R194	321-0327-00		RES., FXD, FILM: 24.9K OHM, 1%, 0.125W	91637	MFF1816G24901F
R195	311-1198-00		RES., VAR, NONWIR: 20K OHM, 20%, 0.5W	01121	E4A203
R197	321-0194-00		RES., FXD, FILM: 1.02K OHM, 1%, 0.125W	91637	MFF1816G10200F
R199	315-0753-00		RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R200	311-1860-00		RES., VAR, NONWIR: TRMR, 10K OHM, 0.50W	32997	3299X-R27-103
R203	315-0335-00		RES., FXD, CMPSN: 3.3M OHM, 5%, 0.25W	01121	CB3355
R204	315-0364-00		RES., FXD, CMPSN: 360K OHM, 5%, 0.25W	01121	CB3645
	-----		(STANDARD AND OPTION 20 ONLY)		
R204	315-0125-00	B010100 B030649	RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
	-----		(OPTION 22 ONLY)		
R204	315-0105-00	B030650	RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
	-----		(OPTION 22 ONLY)		
R206	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R207	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
R208	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
R210	311-1524-00	B010100 B030799	RES., VAR, NONWIR: 20K OHM, 10%, 1W	01121	73A1G040L203U
R210	311-1995-00	B030800	RES., VAR, NONWIR: PNL, 20K OHM, 10%, 1W	01121	73A1G032L203U
R222	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R223	315-0433-00		RES., FXD, CMPSN: 43K OHM, 5%, 0.25W	01121	CB4335
R224	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R226	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R229	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R230	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R231	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R236	315-0473-00	B010100 B019999	RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R236	315-0183-00	B020000	RES., FXD, CMPSN: 18K OHM, 5%, 0.25W	01121	CB1835
R237	315-0204-00		RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R238	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R239	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R243	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R244	315-0512-00		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R246	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R247	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R249	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R252	315-0563-00		RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R253	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R256	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R291	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R296	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R297	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R309	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R311	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R312	321-0481-00		RES., FXD, FILM: 1M OHM, 1%, 0.125W	91637	MFF1816G10003F
R314	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R316	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R317	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R321	315-0163-00		RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R323	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R324	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R326	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R327	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R329	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R331	315-0185-00		RES., FXD, CMPSN: 1.8M OHM, 5%, 0.25W	01121	CB1855
R333	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R336	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R337	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R341	315-0393-00		RES., FXD, CMPSN: 39K OHM, 5%, 0.25W	01121	CB3935
R342	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R343	315-0106-00		RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R346	315-0164-00		RES., FXD, CMPSN: 160K OHM, 5%, 0.25W	01121	CB1645
R349	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R356	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R357	315-0622-00		RES., FXD, CMPSN: 6.2K OHM, 5%, 0.25W	01121	CB6225
R358	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R359	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R361	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R363	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R363	315-0135-00		(STANDARD AND OPTION 20 ONLY) RES., FXD, CMPSN: 1.3M OHM, 5%, 0.25W	01121	CB1355
R366	315-0564-00		(OPTION 22 ONLY) RES., FXD, CMPSN: 560K OHM, 5%, 0.25W	01121	CB5645
R367	315-0364-00		RES., FXD, CMPSN: 360K OHM, 5%, 0.25W	01121	CB3645
R371	315-0684-00		RES., FXD, CMPSN: 680K OHM, 5%, 0.25W	01121	CB6845
R373	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R374	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R378	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R379	315-0125-00		RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
R381	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
R382	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R383	315-0113-00		RES., FXD, CMPSN: 11K OHM, 5%, 0.25W	01121	CB1135
R384	315-0562-00		RES., FXD, CMPSN: 5.6K OHM, 5%, 0.25W	01121	CB5625
R387	315-0164-00		RES., FXD, CMPSN: 160K OHM, 5%, 0.25W	01121	CB1645
R391	315-0334-00		RES., FXD, CMPSN: 330K OHM, 5%, 0.25W	01121	CB3345
R392	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R405	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R406	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R407	321-0385-00		RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R413	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R414	321-0289-00		RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R423	321-0260-00		RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R424	321-0297-00		RES., FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R425	311-1248-00		RES., VAR, NONWIR: 500 OHM, 10%, 0.50W	73138	72X-23-0-501K
R426	321-0164-00		RES., FXD, FILM: 499 OHM, 1%, 0.125W	91637	MFF1816G49900F
R427	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R429	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R431	321-0160-00		RES., FXD, FILM: 453 OHM, 1%, 0.125W	91637	MFF1816G453R0F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
R432	321-0160-00			RES., FXD, FILM: 453 OHM, 1%, 0.125W	91637	MFF1816G453R0F
R433	321-0268-00			RES., FXD, FILM: 6.04K OHM, 1%, 0.125W	91637	MFF1816G60400F
R436	321-0257-00			RES., FXD, FILM: 4.64K OHM, 1%, 0.125W	91637	MFF1816G46400F
R437	321-0257-00			RES., FXD, FILM: 4.64K OHM, 1%, 0.125W	91637	MFF1816G46400F
R438	321-0385-00	B010100	B020291	RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R438	321-0356-00	B020292		RES., FXD, FILM: 49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R439	321-0385-00	B010100	B020291	RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R439	321-0356-00	B020292		RES., FXD, FILM: 49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R441	315-0163-00			RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R446	321-0280-00			RES., FXD, FILM: 8.06K OHM, 1%, 0.125W	91637	MFF1816G80600F
R447	321-0222-00			RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
R449	321-0389-00	B010100	B019999	RES., FXD, FILM: 110K OHM, 1%, 0.125W	91637	MFF1816G11002F
R449	321-0360-00	B020000		RES., FXD, FILM: 54.9K OHM, 1%, 0.125W	91637	MFF1816G54901F
R450	311-1241-00	B010100	B019999	RES., VAR, NONWIR: 100K OHM, 10%, 0.5W	32997	3386X-T07-104
R450	311-1246-00	B020000		RES., VAR, NONWIR: 50K OHM, 10%, 0.50W	02111	63X-503-T602
R452	321-0194-00			RES., FXD, FILM: 1.02K OHM, 1%, 0.125W	91637	MFF1816G10200F
R454	315-0753-00			RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R455	311-1860-00			RES., VAR, NONWIR: TRMR, 10K OHM, 0.50W	32997	3299X-R27-103
R461	321-0222-00	B010100	B030799	RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
R461	321-0222-07			RES., FXD, FILM: 2K OHM, 0.1%, 0.125W	91637	MFF1816C20000B
R462	321-0222-00	B010100	B030799	RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
R462	321-0222-07			RES., FXD, FILM: 2K OHM, 0.1%, 0.125W	91637	MFF1816C20000B
R464	315-0103-00	B010100	B020291	RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R464	315-0512-00	B020292		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R465	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R466	315-0103-00	B010100	B020291	RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R466	315-0512-00	B020292		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R467	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R468	315-0103-00	B010100	B020291	RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R468	315-0512-00	B020292		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R469	315-0103-00	B010100	B020291	RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R469	315-0512-00	B020292		RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R470	311-1939-00			RES., VAR, NONWIR: PNL, 20K OHM, 20%, 1W	01121	0BD
R473	315-0335-00			RES., FXD, CMPSN: 3.3M OHM, 5%, 0.25W (OPTION 22 ONLY)	01121	CB3355
R473	315-0155-00			RES., FXD, CMPSN: 1.5M OHM, 5%, 0.25W (STANDARD AND OPTION 20 ONLY)	01121	CB1555
R474	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R475	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R476	315-0204-00			RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R477	315-0513-00			RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R479	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R481	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R482	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R483	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R484	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R491	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R496	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R497	321-0289-00			RES., FXD, FILM: 10K OHM, 1%, 0.125W	91637	MFF1816G10001F
R509	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R511	315-0105-00	B010100	B020291	RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R511	315-0225-00	B020292		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R512	315-0105-00	B010100	B020291	RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R512	315-0225-00	B020292		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R514	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R516	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R517	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R521	315-0163-00			RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R523	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R524	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R526	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R527	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R529	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R531	315-0185-00	B010100 B030599	RES., FXD, CMPSN: 1.8M OHM, 5%, 0.25W	01121	CB1855
R531	315-0105-00	B030600	RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R533	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R536	315-0683-00	B010100 B030599	RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R536	315-0682-00	B030600	RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W	01121	CB6825
R537	315-0513-00	B010100 B030599	RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R537	315-0512-00	B030600	RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R541	315-0393-00		RES., FXD, CMPSN: 39K OHM, 5%, 0.25W	01121	CB3935
R542	315-0303-00		RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R543	315-0106-00		RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R546	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R549	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R557	315-0623-00		RES., FXD, CMPSN: 62K OHM, 5%, 0.25W	01121	CB6235
R558	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R559	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R562	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R563	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R566	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
R567	315-0135-00		RES., FXD, CMPSN: 1.3M OHM, 5%, 0.25W	01121	CB1355
	-----		(OPTION 20 ONLY)		
R567	315-0185-00		RES., FXD, CMPSN: 1.8M OHM, 5%, 0.25W	01121	CB1855
	-----		(STANDARD AND OPTION 22 ONLY)		
R571	315-0684-00		RES., FXD, CMPSN: 680K OHM, 5%, 0.25W	01121	CB6845
R573	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R574	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R578	315-0164-00		RES., FXD, CMPSN: 160K OHM, 5%, 0.25W	01121	CB1645
R581	315-0334-00		RES., FXD, CMPSN: 330K OHM, 5%, 0.25W	01121	CB3345
R582	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R586	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R587	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R588	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R593	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R594	315-0513-00		RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R611	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R617	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R618	315-0563-00		RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R619	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R621	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R623	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R624	315-0244-00		RES., FXD, CMPSN: 240K OHM, 5%, 0.25W	01121	CB2445
R628	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R629	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R635	311-1298-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	01121	W-7909
R636	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
R637	315-0183-00		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W	01121	CB1835
R639	315-0274-00		RES., FXD, CMPSN: 270K OHM, 5%, 0.25W	01121	CB2745
R643	315-0204-00		RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R646	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R647	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
R653	315-0204-00		RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R656	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
R657	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R661	131-0566-00		LINK, TERM. CONNE: 0.086 DIA X 2.375 INCH L	55210	L-2007-1
R662	315-0153-00		RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R666	315-0560-00		RES., FXD, CMPSN: 56 OHM, 5%, 0.25W	01121	CB5605
R667	321-0342-00		RES., FXD, FILM: 35.7K OHM, 1%, 0.125W	91637	MFF1816G35701F
R670	315-0332-00		RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121	CB3325

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R671	321-0377-00			RES., FXD, FILM: 82.5K OHM, 1%, 0.125W	91637	MFF1816G82501F
R676	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R679	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R686	321-0385-00			RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R688	315-0335-00			RES., FXD, CMPSN: 3.3M OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB3355
R689	321-0807-00			RES., FXD, FILM: 900K OHM, 1%, 0.125W (STANDARD AND OPTION 22 ONLY)	91637	HFF1104F90002F
R690	311-1247-00			RES., VAR, NONWIR: 1M OHM, 10%, 0.50W (STANDARD AND OPTION 22 ONLY)	73138	72X-35-0-105K
R691	315-0304-00			RES., FXD, CMPSN: 300K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB3045
R692	315-0125-00			RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
R696	321-0414-00			RES., FXD, FILM: 200K OHM, 1%, 0.125W (STANDARD ONLY)	91637	MFF1816G20002F
R697	321-0807-00			RES., FXD, FILM: 900K OHM, 1%, 0.125W	91637	HFF1104F90002F
R698	321-0720-02			RES., FXD, FILM: 60K OHM, 0.5%, 0.125W	91637	MFF1816D60001D
R702	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R703	315-0203-00	B010100	B030649	RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R703	315-0243-00	B030650		RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
R704	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R706	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R707	315-0125-00			RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
R709	315-0332-00			RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121	CB3325
R717	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R719	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R721	321-0414-00			RES., FXD, FILM: 200K OHM, 1%, 0.125W	91637	MFF1816G20002F
R722	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R723	321-0356-00			RES., FXD, FILM: 49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R736	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R751	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R752	321-0356-00			RES., FXD, FILM: 49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
R753	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R756	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R757	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R765	311-1856-00			RES., VAR, NONWIR: PNL, 2.5M OHM, 1W, 4PST (FURNISHED AS A UNIT WITH S765)	01121	14M352
R767	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB3315
R768	321-0373-00			RES., FXD, FILM: 75K OHM, 1%, 0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G75001F
R769	321-0376-00			RES., FXD, FILM: 80.6K OHM, 1%, 0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G80601F
R772	321-0393-00			RES., FXD, FILM: 121K OHM, 1%, 0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G12102F
R773	315-0621-00			RES., FXD, CMPSN: 620 OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB6215
R774	315-0114-00			RES., FXD, CMPSN: 110K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1145
R776	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R787	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB3315
R789	321-0373-00			RES., FXD, FILM: 75K OHM, 1%, 0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G75001F
R792	315-0474-00			RES., FXD, CMPSN: 470K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB4745
R794	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R796	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1055

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R797	315-0364-00		RES.,FXD,CMPSN:360K OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB3645
R806	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB4705
R807	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R807	-----		(STANDARD AND OPTION 22 ONLY)		
R808	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB4705
R809	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB4705
R817	321-0396-00		RES.,FXD,FILM:130K OHM,1%,0.125W	91637	MFF1816G13002F
R817	-----		(STANDARD AND OPTION 22 ONLY)		
R819	321-0408-00		RES.,FXD,FILM:174K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G17402F
R821	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1025
R822	315-0106-00		RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
R822	-----		(STANDARD AND OPTION 22 ONLY)		
R826	321-0618-00		RES.,FXD,FILM:250K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G25002F
R827	321-0350-00		RES.,FXD,FILM:43.2K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G43201F
R831	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R831	-----		(STANDARD AND OPTION 22 ONLY)		
R836	321-0618-00		RES.,FXD,FILM:250K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G25002F
R837	321-0289-00		RES.,FXD,FILM:10K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G10001F
R841	315-0393-00		RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R841	-----		(STANDARD AND OPTION 22 ONLY)		
R842	315-0623-00		RES.,FXD,CMPSN:62K OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB6235
R844	315-0225-00		RES.,FXD,CMPSN:2.2M OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB2255
R846	315-0334-00		RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R846	-----		(STANDARD AND OPTION 22 ONLY)		
R851	321-0289-00		RES.,FXD,FILM:10K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G10001F
R852	321-0385-00		RES.,FXD,FILM:100K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G10002F
R854	321-0385-00		RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R854	-----		(STANDARD AND OPTION 22 ONLY)		
R857	321-0720-07		RES.,FXD,FILM:60K OHM,0.1%,0.125W (OPTION 22 ONLY)	91637	MFF1816C60001B
R857	321-0685-07		RES.,FXD,FILM:30K OHM,0.1%,0.125W (STANDARD ONLY)	91637	MFF1816C30001B
R858	321-0720-07		RES.,FXD,FILM:60K OHM,0.1%,0.125W	91637	MFF1816C60001B
R858	-----		(OPTION 22 ONLY)		
R858	321-0685-07		RES.,FXD,FILM:30K OHM,0.1%,0.125W (STANDARD ONLY)	91637	MFF1816C30001B
R859	321-0685-07		RES.,FXD,FILM:30K OHM,0.1%,0.125W (OPTION 22 ONLY)	91637	MFF1816C30001B
R859	321-0603-07		RES.,FXD,FILM:15K OHM,0.1%,0.125W	91637	MFF1816C15001B
R859	-----		(STANDARD ONLY)		
R862	321-0389-00		RES.,FXD,FILM:110K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G11002F
R864	321-0338-00		RES.,FXD,FILM:32.4K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G32401F
R865	311-1198-00		RES.,VAR, NONWIR:20K OHM,20%,0.5W (STANDARD AND OPTION 22 ONLY)	01121	E4A203

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R866	311-1949-00		RES.,VAR, NONWIR:100K OHM,20%,1W (OPTION 2 ONLY)	01121	OB D
R871	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1025
R874	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R874	-----		(STANDARD AND OPTION 22 ONLY)		
R876	321-0361-00		RES.,FXD,FILM:56.2K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G56201F
R877	321-0361-00		RES.,FXD,FILM:56.2K OHM,1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816G56201F
R881	131-0566-00		LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L (OPTION 22 ONLY)	55210	L-2007-1
R881	321-0289-07		RES.,FXD,FILM:10K OHM,0.1%,0.125W (STANDARD ONLY)	91637	MFF1816C10001B
R882	321-0719-07		RES.,FXD,FILM:6.667K OHM,0.1%,0.125W (OPTION 22 ONLY)	91637	CMF110216G66670B
R882	321-0903-01		RES.,FXD,FILM:23.32K OHM,0.5%,0.125W (STANDARD ONLY)	91637	MFF1816G23321D
R883	321-0924-07		RES.,FXD,FILM:40K OHM,0.1%,0.125W (OPTION 22 ONLY)	91637	MFF1816C40001B
R883	321-0993-07		RES.,FXD,FILM:90K OHM,0.1%,0.125W (STANDARD ONLY)	91637	MFF1816C90001B
R884	321-0289-07		RES.,FXD,FILM:10K OHM,0.1%,0.125W (STANDARD AND OPTION 22 ONLY)	91637	MFF1816C10001B
R886	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R906	307-0509-00		RES NTWK,FXD FI:7,100K OHM,5%	01121	208A104
R907	315-0105-00		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R909	321-0222-09		RES.,FXD,FILM:2.00K OHM,1%,0.125W	91637	MFF1816C20000F
R910	311-1861-00		RES.,VAR, NONWIR:TRMR,1K OHM,0.50W	32997	3299X-R270102
R911	321-0201-09		RES.,FXD,FILM:1.21K OHM,1%,0.125W	24546	NE55E1211F
R920	311-1860-00		RES.,VAR, NONWIR:TRMR,10K OHM,0.50W	32997	3299X-R27-103
R921	315-0122-00		RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R924	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R926	321-0193-07		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R927	321-0193-07		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R928	321-0193-07		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R929	321-0193-07		RES.,FXD,FILM:1K OHM,0.1%,0.125W	91637	MFF1816C10000B
R930	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R933	315-0105-00		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R936	315-0513-00		RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R952	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R955	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R957	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R958	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R960	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R961	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R963	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R964	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R966	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R968	315-0275-00		RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R969	315-0275-00		RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R974	315-0562-00		RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R976	307-0508-00		RES NTWK,FXD FI:15,1M OHM,5%,1.125W	01121	316A105
R978	315-0433-00	XB030700	RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R979	315-0433-00		RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R982	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R990	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R991	315-0203-00		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R992	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R993	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R1001	315-0392-00			RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R1002	315-0122-00			RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
R1003	321-0816-03			RES., FXD, FILM: 5K OHM, 0.25%, 0.125W	91637	MFF1816D50000C
R1004	321-1296-03			RES., FXD, FILM: 12K OHM, 0.25%, 0.125W	91637	MFF1816D12001C
R1006	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R1011	315-0106-00			RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R1013	315-0106-00			RES., FXD, CMPSN: 10M OHM, 5%, 0.25W	01121	CB1065
R1016	315-0304-00			RES., FXD, CMPSN: 300K OHM, 5%, 0.25W	01121	CB3045
R1031	315-0302-00			RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
R1032	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1033	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1038	315-0753-00			RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R1039	315-0363-00			RES., FXD, CMPSN: 36K OHM, 5%, 0.25W	01121	CB3635
R1042	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R1043	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1051	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1052	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1053	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1054	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1061	315-0243-00			RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
R1062	315-0133-00			RES., FXD, CMPSN: 13K OHM, 5%, 0.25W	01121	CB1335
R1065	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1066	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1067	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1068	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1069	315-0243-00			RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
R1121	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1122	321-0243-00			RES., FXD, FILM: 3.32K OHM, 1%, 0.125W	91637	MFF1816G33200F
R1123	321-0255-00			RES., FXD, FILM: 4.42K OHM, 1%, 0.125W	91637	MFF1816G44200F
R1124	321-0270-00			RES., FXD, FILM: 6.34K OHM, 1%, 0.125W	91637	MFF1816G63400F
R1126	315-0335-00			RES., FXD, CMPSN: 3.3M OHM, 5%, 0.25W	01121	CB3355
R1127	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1133	307-0509-00			RES NTWK, FXD FI: 7, 100K OHM, 5%	01121	208A104
R1151	315-0684-00			RES., FXD, CMPSN: 680K OHM, 5%, 0.25W	01121	CB6845
R1152	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1153	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1154	315-0623-00			RES., FXD, CMPSN: 62K OHM, 5%, 0.25W	01121	CB6235
R1161	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1162	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1163	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1164	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1179	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1201	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1202	315-0103-00			(STANDARD AND OPTION 22 ONLY) RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1203	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R1206	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1207	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1209	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R1211	315-0114-00			RES., FXD, CMPSN: 110K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1145
R1212	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R1213	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R1216	315-0114-00		RES., FXD, CMPSN: 110K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1145
R1221	321-0993-07		RES., FXD, FILM: 90K OHM, 0.1%, 0.125W	91637	MFF1816C90001B
R1222	321-0289-07		RES., FXD, FILM: 10K OHM, 0.1%, 0.125W	91637	MFF1816C10001B
R1236	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1237	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R1239	315-0114-00		RES., FXD, CMPSN: 110K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1145
R1242	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1243	315-0275-00		RES., FXD, CMPSN: 2.7M OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB2755
R1246	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1247	315-0275-00		RES., FXD, CMPSN: 2.7M OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB2755
R1256	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1035
R1257	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1045
R1259	315-0114-00		RES., FXD, CMPSN: 110K OHM, 5%, 0.25W (STANDARD AND OPTION 22 ONLY)	01121	CB1145
R1311	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1312	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1314	321-0437-00		RES., FXD, FILM: 348K OHM, 1%, 0.125W	91637	MFF1816G34802F
R1315	311-1945-00		RES., VAR, NONWIR: 200K OHM, 10%, 0.50W	73138	68-12-0
R1321	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1322	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1323	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1326	315-0304-00		RES., FXD, CMPSN: 300K OHM, 5%, 0.25W	01121	CB3045
R1332	315-0823-00		RES., FXD, CMPSN: 82K OHM, 5%, 0.25W	01121	CB8235
R1333	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1334	321-0644-00		RES., FXD, FILM: 100K OHM, 0.25%, 0.125W	91637	MFF1816C10002C
R1336	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1337	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1338	315-0114-00		RES., FXD, CMPSN: 110K OHM, 5%, 0.25W	01121	CB1145
R1341	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1342	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1344	321-0434-00		RES., FXD, FILM: 324K OHM, 1%, 0.125W	91637	MFF1816G32402F
R1345	311-1945-00		RES., VAR, NONWIR: 200K OHM, 10%, 0.50W	73138	68-12-0
R1351	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1352	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1353	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1356	315-0304-00		RES., FXD, CMPSN: 300K OHM, 5%, 0.25W	01121	CB3045
R1362	315-0433-00		RES., FXD, CMPSN: 43K OHM, 5%, 0.25W	01121	CB4335
R1363	321-0414-03		RES., FXD, FILM: 200K OHM, 0.25%, 0.125W	24546	NC55C2003C
R1364	321-0756-03		RES., FXD, FILM: 50K OHM, 0.25%, 0.125W	91637	MFF1816D50001C
R1366	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1367	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1368	315-0114-00		RES., FXD, CMPSN: 110K OHM, 5%, 0.25W	01121	CB1145
R1403	321-1296-07		RES., FXD, FILM: 12K OHM, 0.1%, 0.125W	91637	MFF1816C12001B
R1404	321-1682-07		RES., FXD, FILM: 5.7K OHM, 0.1%, 0.125W	91637	MFF1816C57000B
R1406	321-0245-00		RES., FXD, FILM: 3.48K OHM, 1%, 0.125W	91637	MFF1816G34800F
R1408	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1409	321-0191-09		RES., FXD, FILM: 953 OHM, 1%, 0.125W	24546	NE55E9530F
R1412	315-0123-00		RES., FXD, CMPSN: 12K OHM, 5%, 0.25W	01121	CB1235

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R1413	315-0244-00		RES., FXD, CMPSN: 240K OHM, 5%, 0.25W	01121	CB2445
R1417	321-0137-00		RES., FXD, FILM: 261 OHM, 1%, 0.125W	91637	MFF1816G261ROF
R1418	321-0168-00		RES., FXD, FILM: 549 OHM, 1%, 0.125W	91637	MFF1816G549ROF
R1419	321-0190-00		RES., FXD, FILM: 931 OHM, 1%, 0.125W	91637	MFF1816G931ROF
R1424	321-0202-09		RES., FXD, FILM: 1.24K OHM, 1%, 0.125W	91637	MFF1816C12400F
R1425	311-1036-00		RES., VAR, NONWIR: TRMR, 200 OHM, 0.5W	73138	68-76-0
R1426	321-0171-09		RES., FXD, FILM: 590 OHM, 1%, 0.125W	91637	MFF1816C590ROF
R1427	311-1175-00		RES., VAR, NONWIR: 100 OHM, 10%, 0.50W	73138	68WR100
R1428	321-0641-07		RES., FXD, FILM: 1.8K OHM, 0.1%, 0.125W	91637	MFF1816C18000B
R1429	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1434	321-0202-09		RES., FXD, FILM: 1.24K OHM, 1%, 0.125W	91637	MFF1816C12400F
R1435	311-1944-00		RES., VAR, NONWIR: 1K OHM, 10%, 0.50W	32997	3299W-R27-102
R1436	321-0249-09		RES., FXD, FILM: 3.83K OHM, 1%, 0.125W	91637	MFF1816C38300F
R1439	321-0240-00		RES., FXD, FILM: 3.09K OHM, 1%, 0.125W	91637	MFF1816G30900F
R1442	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1443	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1445	311-1943-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	73138	MODEL 68W
R1446	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1447	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1463	321-1296-07		RES., FXD, FILM: 12K OHM, 0.1%, 0.125W	91637	MFF1816C12001B
R1464	321-1682-07		RES., FXD, FILM: 5.7K OHM, 0.1%, 0.125W	91637	MFF1816C57000B
R1466	321-0245-00		RES., FXD, FILM: 3.48K OHM, 1%, 0.125W	91637	MFF1816G34800F
R1468	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1469	321-0191-09		RES., FXD, FILM: 953 OHM, 1%, 0.125W	24546	NE55E9530F
R1472	315-0123-00		RES., FXD, CMPSN: 12K OHM, 5%, 0.25W	01121	CB1235
R1473	315-0244-00		RES., FXD, CMPSN: 240K OHM, 5%, 0.25W	01121	CB2445
R1477	321-0137-00		RES., FXD, FILM: 261 OHM, 1%, 0.125W	91637	MFF1816G261ROF
R1478	321-0168-00		RES., FXD, FILM: 549 OHM, 1%, 0.125W	91637	MFF1816G549ROF
R1479	321-0190-00		RES., FXD, FILM: 931 OHM, 1%, 0.125W	91637	MFF1816G931ROF
R1484	321-0202-09		RES., FXD, FILM: 1.24K OHM, 1%, 0.125W	91637	MFF1816C12400F
R1485	311-1036-00		RES., VAR, NONWIR: TRMR, 200 OHM, 0.5W	73138	68-76-0
R1486	321-0171-09		RES., FXD, FILM: 590 OHM, 1%, 0.125W	91637	MFF1816C590ROF
R1487	311-1175-00		RES., VAR, NONWIR: 100 OHM, 10%, 0.50W	73138	68WR100
R1488	321-0641-07		RES., FXD, FILM: 1.8K OHM, 0.1%, 0.125W	91637	MFF1816C18000B
R1489	321-0193-07		RES., FXD, FILM: 1K OHM, 0.1%, 0.125W	91637	MFF1816C10000B
R1505	311-1865-00		RES., VAR, NONWIR: PNL, 50K OHM, 1W, 4PST (FURNISHED AS A UNIT WITH S1505)	01121	15M011
R1506	321-0189-00		RES., FXD, FILM: 909 OHM, 1%, 0.125W	91637	MFF1816G909ROF
R1507	321-0211-00		RES., FXD, FILM: 1.54K OHM, 1%, 0.125W	91637	MFF1816G15400F
R1511	321-0828-03		RES., FXD, FILM: 2.4K OHM, 0.25%, 0.125W	91637	MFF1816D24000C
R1512	321-0828-03		RES., FXD, FILM: 2.4K OHM, 0.25%, 0.125W (STANDARD AND OPTION 20 ONLY)	91637	MFF1816D24000C
R1512	321-0609-07		RES., FXD, FILM: 480 OHM, 0.1%, 0.125W (OPTION 22 ONLY)	91637	MFF1816C480ROB
R1513	321-1296-03		RES., FXD, FILM: 12K OHM, 0.25%, 0.125W	91637	MFF1816D12001C
R1515	311-1866-00		RES., VAR, NONWIR: PNL, 50K OHM, 1W (FURNISHED AS A UNIT WITH S1515)	01121	15M010
R1516	321-0189-00		RES., FXD, FILM: 909 OHM, 1%, 0.125W	91637	MFF1816G909ROF
R1517	321-0211-00		RES., FXD, FILM: 1.54K OHM, 1%, 0.125W	91637	MFF1816G15400F
R1522	315-0125-00		RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255
R1523	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1531	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1532	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1533	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1536	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1537	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W (STANDARD AND OPTION 20 ONLY)	01121	CB1845
R1537	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 22 ONLY)	01121	CB1045
R1543	315-0125-00		RES., FXD, CMPSN: 1.2M OHM, 5%, 0.25W	01121	CB1255

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R1544	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1547	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1551	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1554	315-0224-00		RES., FXD, CMPSN: 220K OHM, 5%, 0.25W	01121	CB2245
R1556	315-0434-00		RES., FXD, CMPSN: 430K OHM, 5%, 0.25W	01121	CB4345
R1557	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1561	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1562	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1563	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1564	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1566	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1571	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1572	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1574	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1576	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R1581	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1582	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1587	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1588	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1590	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R1591	315-0475-00		RES., FXD, CMPSN: 4.7M OHM, 5%, 0.25W	01121	CB4755
R1592	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1593	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1610	311-1226-00		RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	32997	3386F-T04-252
R1611	321-0297-00		RES., FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R1613	321-0366-00		RES., FXD, FILM: 63.4K OHM, 1%, 0.125W	91637	MFF1816G63401F
R1616	321-0385-00		RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R1617	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1619	321-0373-00		RES., FXD, FILM: 75K OHM, 1%, 0.125W	91637	MFF1816G75001F
R1621	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1631	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1636	315-0134-00		RES., FXD, CMPSN: 130K OHM, 5%, 0.25W	01121	CB1345
R1637	315-0154-00		RES., FXD, CMPSN: 150K OHM, 5%, 0.25W	01121	CB1545
R1641	315-0202-00		RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R1642	315-0273-00		RES., FXD, CMPSN: 27K OHM, 5%, 0.25W	01121	CB2735
R1646	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1647	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1652	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R1653	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R1658	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R1659	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1662	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R1663	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R1667	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
R1672	315-0473-00		RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R1677	315-0330-00		RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
R1684	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1685	311-1222-00		RES., VAR, NONWIR: 100 OHM, 20%, 0.50W	32997	3386F-T04-101
R1686	321-0142-00		RES., FXD, FILM: 294 OHM, 1%, 0.125W	91637	MFF1816G294R0F
R1687	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R1701	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1702	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1704	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1706	315-0474-00		RES., FXD, CMPSN: 470K OHM, 5%, 0.25W	01121	CB4745
R1712	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1713	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R1714	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1725	315-0151-00		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R1727	315-0331-00		RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
R1729	315-0151-00		RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1731	311-1521-00			RES., VAR, NONWIR: 100K OHM, 20%, 1W	01121	73A1G032L104M
R1732	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1733	311-1521-00			RES., VAR, NONWIR: 100K OHM, 20%, 1W	01121	73A1G032L104M
R1734	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1742	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R1751	321-0420-00			RES., FXD, FILM: 232K OHM, 1%, 0.125W	91637	MFF1816G23202F
R1752	321-0030-00			RES., FXD, FILM: 20 OHM, 1%, 0.125W	91637	MFF1816G20R00F
R1753	321-0001-00			RES., FXD, FILM: 10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R1758	315-0154-00			RES., FXD, CMPSN: 150K OHM, 5%, 0.25W	01121	CB1545
R1771	315-0204-00			RES., FXD, CMPSN: 200K OHM, 5%, 0.25W	01121	CB2045
R1774	315-0563-00			RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R1776	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1777	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1783	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1784	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1792	315-0563-00			RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R1793	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1794	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1812	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R1813	315-0393-00			RES., FXD, CMPSN: 39K OHM, 5%, 0.25W	01121	CB3935
R1814	315-0563-00			RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R1820	307-0573-00			RES. NTKW, FXD FI: (9) 100K, (11) 200K OHM, 2%	01121	314 L10104
R1834	315-0153-00			RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R1835	311-1228-00			RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	32997	3386F-T04-103
R1836	315-0913-00			RES., FXD, CMPSN: 91K OHM, 5%, 0.25W	01121	CB9135
R1842	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1844	321-0352-00			RES., FXD, FILM: 45.3K OHM, 1%, 0.125W	91637	MFF1816G45301F
R1845	311-1231-00			RES., VAR, NONWIR: 25K OHM, 20%, 0.50W	32997	3386F-T04-253
R1847	321-0363-00			RES., FXD, FILM: 59K OHM, 1%, 0.125W	91637	MFF1816G59001F
R1852	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1857	321-0365-00			RES., FXD, FILM: 61.9K OHM, 1%, 0.125W	91637	MFF1816G61901F
R1858	321-0385-00			RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R1913	301-0150-00			RES., FXD, CMPSN: 15 OHM, 5%, 0.50W	01121	EB1505
R1918	321-0320-00			RES., FXD, FILM: 21K OHM, 1%, 0.125W	91637	MFF1816G21001F
R1919	321-0320-00			RES., FXD, FILM: 21K OHM, 1%, 0.125W	91637	MFF1816G21001F
R1923	321-0320-00			RES., FXD, FILM: 21K OHM, 1%, 0.125W	91637	MFF1816G21001F
R1926	321-0368-00			RES., FXD, FILM: 66.5K OHM, 1%, 0.125W	91637	MFF1816G66501F
R1927	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1928	315-0162-00			RES., FXD, CMPSN: 1.6K OHM, 5%, 0.25W	01121	CB1625
R1936	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1937	315-0471-00			RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
R1939	315-0222-00			RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R1942	315-0222-00			RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R1943	308-0677-00	B010100	B031439	RES., FXD, WW: 1 OHM, 5%, 2W	75042	BWH-1R000J
R1943	308-0822-00	B031440		RES., FXD, WW: 1.3 OHM, 5%, 2W	75042	BWF 1.3 OHM
R1944	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1945	301-0750-00			RES., FXD, CMPSN: 75 OHM, 5%, 0.50W	01121	EB7505
R1959	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1961	315-0333-00			RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1962	315-0333-00			RES., FXD, CMPSN: 33K OHM, 5%, 0.25W	01121	CB3335
R1963	315-0154-00			RES., FXD, CMPSN: 150K OHM, 5%, 0.25W	01121	CB1545
R1966	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1967	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R1969	315-0330-00			RES., FXD, CMPSN: 33 OHM, 5%, 0.25W	01121	CB3305
R1981	321-0149-00	XB030800		RES., FXD, FILM: 348 OHM, 1%, 0.125W	91637	MFF1816G348R0F
R1984	315-0332-00			RES., FXD, CMPSN: 3.3K OHM, 5%, 0.25W	01121	CB3325
R1987	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1989	321-0228-09			RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637	MFF1816C23200F
R1990	311-1223-00			RES., VAR, NONWIR: 250 OHM, 10%, 0.50W	32997	3386F-T04-251
R1991	321-0228-09			RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637	MFF1816C23200F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R1993	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R1996	321-0289-07		RES., FXD, FILM: 10K OHM, 0.1%, 0.125W	91637	MFF1816C10001B
R1997	321-0924-07		RES., FXD, FILM: 40K OHM, 0.1%, 0.125W	91637	MFF1816C40001B
R2011	321-0272-07		RES., FXD, FILM: 6.65K OHM, 0.1%, 0.125W	91637	MFF1816C66500B
R2012	321-0924-07		RES., FXD, FILM: 40K OHM, 0.1%, 0.125W	91637	MFF1816C40001B
R2013	321-0370-00		RES., FXD, FILM: 69.8K OHM, 1%, 0.125W	91637	MFF1816G69801F
R2014	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R2018	315-0152-00		RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R2019	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R2023	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2026	315-0201-00		RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R2027	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2031	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2032	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2033	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R2042	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2043	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2046	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2047	315-0201-00		RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R2051	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2054	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2061	321-0816-07		RES., FXD, FILM: 5K OHM, 0.1%, 0.125W	91637	MFF1816C50000B
R2062	321-1296-07		RES., FXD, FILM: 12K OHM, 0.1%, 0.125W	91637	MFF1816C12001B
R2064	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2073	315-0223-00		RES., FXD, CMPSN: 22K OHM, 5%, 0.25W	01121	CB2235
R2075	307-0104-00		RES., FXD, CMPSN: 3.3 OHM, 5%, 0.25W	01121	CB33G5
R2077	315-0123-00		RES., FXD, CMPSN: 12K OHM, 5%, 0.25W	01121	CB1235
R2092	307-0104-00		RES., FXD, CMPSN: 3.3 OHM, 5%, 0.25W	01121	CB33G5
R2097	315-0223-00		RES., FXD, CMPSN: 22K OHM, 5%, 0.25W	01121	CB2235
R2121	315-0225-00		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R2131	315-0225-00		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R2132	315-0225-00		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R2133	315-0225-00		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R2134	315-0225-00		RES., FXD, CMPSN: 2.2M OHM, 5%, 0.25W	01121	CB2255
R2137	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
R2140	311-1255-00		RES., VAR, NONWIR: 2M OHM, 20%, 0.50W	32997	3386F-T04-205
R2142	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2143	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2154	315-0475-00		RES., FXD, CMPSN: 4.7M OHM, 5%, 0.25W	01121	CB4755
R2156	316-0825-00		RES., FXD, CMPSN: 8.2M OHM, 10%, 0.25W	01121	CB8251
R2161	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
R2163	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2211	315-0563-00		RES., FXD, CMPSN: 56K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB5635
R2212	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1045
R2213	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1045
R2216	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1045
R2231	315-0183-00		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1835
R2232	315-0333-00		RES., FXD, CMPSN: 33K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB3335
R2233	315-0273-00		RES., FXD, CMPSN: 27K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB2735
R2236	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1045
R2247	315-0104-00	XB020440	RES., FXD, CMPSN: 100K OHM, 5%, 0.25W (OPTION 5 ONLY)	01121	CB1045

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R2256	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB1035
R2257	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB1035
R2273	307-0573-00			RES NTWK,FXD FI:(9)100K,(11)200K OHM,2% (OPTION 5 ONLY)	01121	314 L10104
R2277	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W (OPTION 5 ONLY)	91637	MFF1816G10002F
R2279	311-1267-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W (OPTION 5 ONLY)	32997	3329P-L58-502
R2280	321-0384-00			RES.,FXD,FILM:97.6K OHM,1%,0.125W (OPTION 5 ONLY)	91637	MFF1816G97601F
R2282	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W (OPTION 5 ONLY)	91637	MFF1816G10002F
R2283	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB2035
R2284	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB2035
R2287	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB2035
R2289	311-1879-00			RES.,VAR,NONWIR:20K OHM,0.50W (OPTION 5 ONLY)	73138	68-6-0
R2290	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB1035
R2291	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W (OPTION 5 ONLY)	01121	CB1015
RT1690	-----			(FURNISHED AS A UNIT WITH L1690)		
RT1922	307-1097-01			RES.,THERMAL:32K OHM,2% AT 50 DEG C	80009	307-1097-01
S101	260-1213-00	B010100	B031439	SWITCH,PUSH:DPDT,1A,28VDC	80009	260-1213-00
S101	260-1213-02	B031440		SWITCH,PUSH:4 BUTTON,2 POLE,LEAD SEL	80009	260-1213-02
S405	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT	80009	260-1771-00
S605	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT (OPTION 20 ONLY)	80009	260-1771-00
S605	260-1881-00			SWITCH,PUSH:2 & 4 POLE,6 BUTTON (STANDARD AND OPTION 22 ONLY)	80009	260-1881-00
S765	-----			(FURNISHED AS A UNIT WITH R765)		
S1135	260-1423-00			SWITCH,PUSH:4 STA,INTERLOCK,NON-SHORT (OPTION 20 ONLY)	80009	260-1423-00
S1135	260-1882-00			SWITCH,PUSH:2 POLE,6 BTN,READOUT SELECT (STANDARD AND OPTION 22 ONLY)	80009	260-1882-00
S1426	260-1879-00			SWITCH,ROTARY:TEMPERATURE SELECTOR	81073	71A30-01-4-02N
S1505	-----			(FURNISHED AS A UNIT WITH R1505)		
S1510	-----			(FURNISHED AS A UNIT WITH 670-5075-XX)		
S1515	-----			(FURNISHED AS A UNIT WITH R1515)		
S1532	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT	80009	260-1771-00
S1554	-----			(FURNISHED AS A UNIT WITH 670-5075-XX)		
S1559	260-1686-00			SWITCH,PUSH:1 STA,2 POLE,MOMENTARY (FURNISHED AS A UNIT WITH 670-5075-XX)	80009	260-1686-00
S1782	-----			(FURNISHED AS A UNIT WITH 670-5075-XX)		
S1910	260-1300-01			SWITCH,SLIDE:DPDT,3A,125V	82389	11A-1354
S1956	260-1771-00			SWITCH,PUSH:1 BUTTON,DPDT (FURNISHED AS A UNIT WITH 670-5075-XX)	80009	260-1771-00
T110	120-0947-00			XFMR,SIGNAL:POT CORE	80009	120-0947-00
T162	120-1126-00			TRANSFORMER,RF:SIGNAL INPUT,POT CORE	80009	120-1126-00
T422	120-1127-00			TRANSFORMER,RF:ISOLATION,POTCORE	80009	120-1127-00
T1010	120-1042-00			XFMR,PWR,STU:READOUT,POT CORE	80009	120-1042-00
T1910	120-1128-00			XFMR,PWR,STPDN:	80009	120-1128-00
T1972	120-1125-00			XFMR,PWR,SDN&SU:POT CORE	80009	120-1125-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U147	156-0158-00	B010100	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U147	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U181	156-0853-00	B010100	B019999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U181	156-0158-00	B020000	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U181	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U187	156-0853-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U187	156-0853-02	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0853-02
U215	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U215	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U291	156-0853-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U291	156-0853-02	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0853-02
U306	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U306	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U321	156-0912-00			MICROCIRCUIT,LI:OPNL TRANSCONDUCTOR AMPL	80009	156-0912-00
U371	156-0402-00	B010100	B041499	MICROCIRCUIT,LI:TIMER	80009	156-0402-00
U371	156-0402-03	B041500		MICROCIRCUIT,LI:TIMER,TESTED	80009	156-0402-03
U408	156-0912-00			MICROCIRCUIT,LI:OPNL TRANSCONDUCTOR AMPL	80009	156-0912-00
U412	156-0742-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0742-00
U430	156-0534-00			MICROCIRCUIT,LI:DUAL DIFF AMPL,14 LD DIP	80009	156-0534-00
U439	156-0853-00	B010100	B020439	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U439	156-0158-00	B020400	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U439	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U446	156-0853-00	B010100	B020439	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U446	156-0158-00	B020440	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U446	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U466	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U466	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U491	156-0853-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U491	156-0853-02	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0853-02
U506	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U506	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U523	156-0912-00	B010100	B041499	MICROCIRCUIT,LI:OPNL TRANSCONDUCTOR AMPL	80009	156-0912-00
U571	156-0402-00	B010100	B041499	MICROCIRCUIT,LI:TIMER	80009	156-0402-00
U571	156-0402-03	B041500		MICROCIRCUIT,LI:TIMER,TESTED	80009	156-0402-03
U591	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U591	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U592	156-0513-00	B010100	B041499	MICROCIRCUIT,DI:8-CHAN MUX	80009	156-0513-00
U592	156-0513-02	B041500		MICROCIRCUIT,DI:8-CHANNEL MUX,SEL	80009	156-0513-02
U615	156-0512-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM308N
U615	156-0512-02	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER(SEL)	80009	156-0512-02
U619	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U619	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U639	156-0853-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U639	156-0853-02	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0853-02
U702	156-0853-00	B010100	B030649	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL	80009	156-0853-00
U702	156-0158-00	B030650	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U702	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U711	156-0745-00			MICROCIRCUIT,DI:HEX INVERTER	80009	156-0745-00
U726	156-0350-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U726	156-0350-05	B041500		MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
U729	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U729	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U736	156-0523-00			MICROCIRCUIT,DI:7-STAGE BINARY COUNTER	80009	156-0523-00
U737	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U737	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U739	156-0350-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE (STANDARD AND OPTION 22 ONLY)	80009	156-0350-00
U739	156-0350-05	B041500		MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK (STANDARD AND OPTION 22 ONLY)	80009	156-0350-05
U741	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00

Replaceable Electrical Parts—413

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U752	156-0158-00	B010100	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U752	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U770	156-0853-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,DUAL (STANDARD AND OPTION 22 ONLY)	80009	156-0853-00
U770	156-0853-02	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK (STANDARD AND OPTION 22 ONLY)	80009	156-0853-02
U824	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U824	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U872	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U872	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U920	156-0751-00			MICROCIRCUIT,LI:ADC SUBSYSTEM	04713	MC1405L
U925	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U926	156-0200-00	B010100	B041499	MICROCIRCUIT,LI:LOW INPUT/OFFSET CURRENT	80009	156-0200-00
U926	156-0200-02	B041500		MICROCIRCUIT,LI:OPNL AMPL	80009	156-0200-02
U927	156-0200-00	B010100	B041499	MICROCIRCUIT,LI:LOW INPUT/OFFSET CURRENT	80009	156-0200-00
U927	156-0200-02	B041500		MICROCIRCUIT,LI:OPNL AMPL	80009	156-0200-02
U928	156-0067-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U928	156-0067-12	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U934	156-0494-00	B010100	B041499	MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
U934	156-0494-02	B041500		MICROCIRCUIT,DI:HEX INV/BUFF,SELECTED	80009	156-0494-02
U935	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U935	156-0366-02	B041500		MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
U946	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U946	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U947	156-0749-00			MICROCIRCUIT,DI:3.5 DIGIT A/DLOGIC SS	04713	MC14435
U951	156-0525-00	B010100	B041499	MICROCIRCUIT,DI:DUAL J-K MASTER SLAVE F-F	80009	156-0525-00
U951	156-0525-03	B041500		MICROCIRCUIT,DI:DUAL J-K MASTER SLAVE FF	80009	156-0525-03
U952	156-0754-00			MICROCIRCUIT,DI:DUAL 4-INPUT NOR GATES	80009	156-0754-00
U973	156-0754-00			MICROCIRCUIT,DI:DUAL 4-INPUT NOR GATES	80009	156-0754-00
U975	156-0284-00			MICROCIRCUIT,DI:BCD-7 SEG DECODER/DRIVER	80009	156-0284-00
U977	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U977	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1001	156-0067-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1001	156-0067-12	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U1021	156-0752-00			MICROCIRCUIT,DI:DUAL BCD UP COUNTER	80009	156-0752-00
U1023	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U1023	156-0366-02	B041500		MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
U1025	156-0525-00	B010100	B041499	MICROCIRCUIT,DI:DUAL J-K MASTER SLAVE F-F	80009	156-0525-00
U1025	156-0525-03	B041500		MICROCIRCUIT,DI:DUAL J-K MASTER SLAVE FF	80009	156-0525-03
U1039	156-0402-00	B010100	B041499	MICROCIRCUIT,LI:TIMER	80009	156-0402-00
U1039	156-0402-03	B041500		MICROCIRCUIT,LI:TIMER,TESTED	80009	156-0402-03
U1123	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1123	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1133	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U1133	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1146	156-0756-00			MICROCIRCUIT,DI:BCD TO DECIMAL DECODER	80009	156-0756-00
U1147	156-0494-00	B010100	B041499	MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
U1147	156-0494-02	B041500		MICROCIRCUIT,DI:HEX INV/BUFF,SELECTED	80009	156-0494-02
U1149	156-0753-00			MICROCIRCUIT,DI:EXPAN 4-W 2-INP AOI GATE	80009	156-0753-00
U1151	156-0350-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U1151	156-0350-05	B041500		MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
U1175	156-0513-00	B010100	B041499	MICROCIRCUIT,DI:8-CHAN MUX	80009	156-0513-00
U1175	156-0513-02	B041500		MICROCIRCUIT,DI:8-CHANNEL MUX,SEL	80009	156-0513-02
U1176	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U1176	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1177	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F (STANDARD AND OPTION 22 ONLY)	80009	156-0366-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
U1177	156-0366-02 -----	B041500	MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK (STANDARD AND OPTION 22 ONLY)	80009	156-0366-02
U1179	156-0750-00	B010100 B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1179	156-0750-01	B031440	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1180	156-0753-00		MICROCIRCUIT,DI:EXPAN 4-W 2-INP AOI GATE	80009	156-0753-00
U1206	156-0495-00 -----	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U1206	156-0495-02 -----	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U1223	156-0644-00		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U1230	156-0495-00 -----	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U1230	156-0495-02 -----	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U1231	156-0466-00 -----		MICROCIRCUIT,DI:QUAD 2-INPUT NAND BUFFER (STANDARD AND OPTION 22 ONLY)	01295	SN74LS37N
U1236	156-0495-00 -----	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U1236	156-0495-02 -----	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U1240	156-0495-00 -----	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL (STANDARD AND OPTION 22 ONLY)	80009	156-0495-00
U1240	156-0495-02 -----	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED (STANDARD AND OPTION 22 ONLY)	80009	156-0495-02
U1312	156-0750-00	B010100 B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1312	156-0750-01	B031440	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1313	156-0644-00		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U1326	156-0750-00	B010100 B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1326	156-0750-01	B031440	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1334	156-0644-00		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U1335	156-0495-00	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1335	156-0495-02	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1342	156-0750-00	B010100 B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1342	156-0750-01	B031440	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1343	156-0644-00 -----		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH (STANDARD AND OPTION 22 ONLY)	80009	156-0644-00
U1406	156-0495-00	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1406	156-0495-02	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1420	156-0495-00	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1420	156-0495-02	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1445	156-0067-00	B010100 B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1445	156-0067-12	B041500	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U1451	156-0349-00	B010100 B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U1451	156-0349-06	B041500	MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1452	156-0644-00		MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U1456	156-0350-00	B010100 B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U1456	156-0350-05	B041500	MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
U1457	156-0350-00	B010100 B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U1457	156-0350-05	B041500	MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
U1466	156-0495-00	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1466	156-0495-02	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1521	156-0495-00	B010100 B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1521	156-0495-02	B041500	MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U1522	156-0350-00	B010100 B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0350-00
U1522	156-0350-05	B041500	MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK	80009	156-0350-05
U1547	156-0793-00		MICROCIRCUIT,DI:DUAL 4-INP NAND GATE	80009	156-0793-00
U1623	156-0366-00	B010100 B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U1623	156-0366-02	B041500	MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
U1626	156-0349-00	B010100 B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
U1626	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1627	156-0349-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0349-00
U1627	156-0349-06	B041500		MICROCIRCUIT,DI:QUAD 2 INP NOR GATE,CHK	80009	156-0349-06
U1632	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U1633	156-0750-00	B010100	B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1633	156-0750-01	B031440		MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1649	156-0067-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1649	156-0067-12	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U1702	156-0494-00	B010100	B041499	MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
U1702	156-0494-02	B041500		MICROCIRCUIT,DI:HEX INV/BUFF,SELECTED	80009	156-0494-02
U1706	156-0750-00	B010100	B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-00
U1706	156-0750-01	B031440		MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0750-01
U1707	156-0575-00	B010100	B041499	MICROCIRCUIT,DI:3 INPUT NOR GATE	80009	156-0575-00
U1707	156-0575-03	B041500		MICROCIRCUIT,DI:3 INPUT NOR GATE,SELECTED	80009	156-0575-03
U1709	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U1709	156-0366-02	B041500		MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
U1712	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F	80009	156-0366-00
U1712	156-0366-02	B041500		MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
U1745	156-0545-00			MICROCIRCUIT,DI:12-BIT BINARY COUNTER	02735	C04040AE
U1758	156-0067-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1758	156-0067-12	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U1810	156-0545-00			MICROCIRCUIT,DI:12-BIT BINARY COUNTER	02735	C04040AE
U1841	156-0158-00	B010100	B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1841	156-0158-03	B041500		MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK	80009	156-0158-03
U1926	156-0067-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1926	156-0067-12	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-12
U1984	156-0937-00			MICROCIRCUIT,LI:VOLTAGE REFERENCE	80009	156-0937-00
U1987	156-0495-00	B010100	B041499	MICROCIRCUIT,LI:OPNL AMPL	80009	156-0495-00
U1987	156-0495-02	B041500		MICROCIRCUIT,LI:QUAD OPNL AMPL,SELECTED	80009	156-0495-02
U2033	156-0105-00	B010100	B041499	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0105-00
U2033	156-0105-02	B041500		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,SEL	80009	156-0105-02
U2216	156-0750-00	B010100	B031439	MICROCIRCUIT,DI:DUAL MONOSTABLE MV (OPTION 5 ONLY)	80009	156-0750-00
U2216	156-0750-01	B031440		MICROCIRCUIT,DI:DUAL MONOSTABLE MV (OPTION 5 ONLY)	80009	156-0750-01
U2240	156-0545-00			MICROCIRCUIT,DI:12-BIT BINARY COUNTER (OPTION 5 ONLY)	02735	C04040AE
U2241	156-0682-00			MICROCIRCUIT,DI:HEX D FLIP-FLOP (OPTION 5 ONLY)	80009	156-0682-00
U2242	156-0682-00			MICROCIRCUIT,DI:HEX D FLIP-FLOP (OPTION 5 ONLY)	80009	156-0682-00
U2245	156-0582-00			MICROCIRCUIT,DI:BINARY UP/DOWN COUNTER (OPTION 5 ONLY)	80009	156-0582-00
U2246	156-0582-00			MICROCIRCUIT,DI:BINARY UP/DOWN COUNTER (OPTION 5 ONLY)	80009	156-0582-00
U2247	156-0582-00			MICROCIRCUIT,DI:BINARY UP/DOWN COUNTER (OPTION 5 ONLY)	80009	156-0582-00
U2251	156-0545-00			MICROCIRCUIT,DI:12-BIT BINARY COUNTER (OPTION 5 ONLY)	02735	C04040AE
U2252	156-0682-00			MICROCIRCUIT,DI:HEX D FLIP-FLOP (OPTION 5 ONLY)	80009	156-0682-00
U2253	156-0682-00			MICROCIRCUIT,DI:HEX D FLIP-FLOP (OPTION 5 ONLY)	80009	156-0682-00
U2256	156-0745-00			MICROCIRCUIT,DI:HEX INVERTER (OPTION 5 ONLY)	80009	156-0745-00
U2257	156-0350-00	B010100	B041499	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE (STANDARD AND OPTION 22 ONLY)	80009	156-0350-00
U2257	156-0350-05	B041500		MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,CHK (OPTION 5 ONLY)	80009	156-0350-05
U2259	156-0366-00	B010100	B041499	MICROCIRCUIT,DI:DUAL D-TYPE F-F (OPTION 5 ONLY)	80009	156-0366-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
U2259	156-0366-02	B041500	MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK (OPTION 5 ONLY)	80009	156-0366-02
U2266	156-0895-00		MICROCIRCUIT,DI:14-BIT BINARY COUNTER (OPTION 5 ONLY)	80009	156-0895-00
U2267	156-0793-00		MICROCIRCUIT,DI:DUAL 4-INP NAND GATE (OPTION 5 ONLY)	80009	156-0793-00
U2279	156-0158-00	B010100 B041499	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER (OPTION 5 ONLY)	80009	156-0158-00
U2279	156-0158-03	B041500	MICROCIRCUIT,LI:DUAL OPNL AMPL,CHK (OPTION 5 ONLY)	80009	156-0158-03
U2310	150-1039-00	B010100 B031194	LAMP,GLOW,RDOUT:NEON,7 SEGMENT,1.5 DIGIT (OPTION 5 ONLY)	52536	SP331
U2310	150-1039-01	B031195	LAMP,GLOW,RDOUT:NEON,7 SEGMENT,1.5 DIGIT (OPTION 5 ONLY)	73138	SP331-02
U2320	150-1015-00	B010100 B031194	LAMP,GLOW,RDOUT:ORANGE,2.0 DIGIT (OPTION 5 ONLY)	52536	SP332
U2320	150-1015-01	B031195	LAMP,GLOW,RDOUT:ORANGE,2.0 DIGIT (OPTION 5 ONLY)	73138	SP332-01
V2120	154-0508-01		ELECTRON TUBE:CRT	S0482	CT 496 BP7
VR145	152-0195-00		SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR146	152-0195-00		SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR349	152-0195-00		SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR549	152-0195-00		SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR670	152-0217-00		SEMICON D DEVICE:ZENER,0.4W,8.2V,5%	80009	152-0217-00
VR709	152-0217-00		SEMICON D DEVICE:ZENER,0.4W,8.2V,5%	80009	152-0217-00
VR871	152-0279-00	XB031440	SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00
VR872	152-0279-00	XB031440	SEMICON D DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00
VR1961	152-0149-00		SEMICON D DEVICE:ZENER,0.4W,10V,5%	80009	152-0149-00



DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μ F).

Resistors = Ohms (Ω).

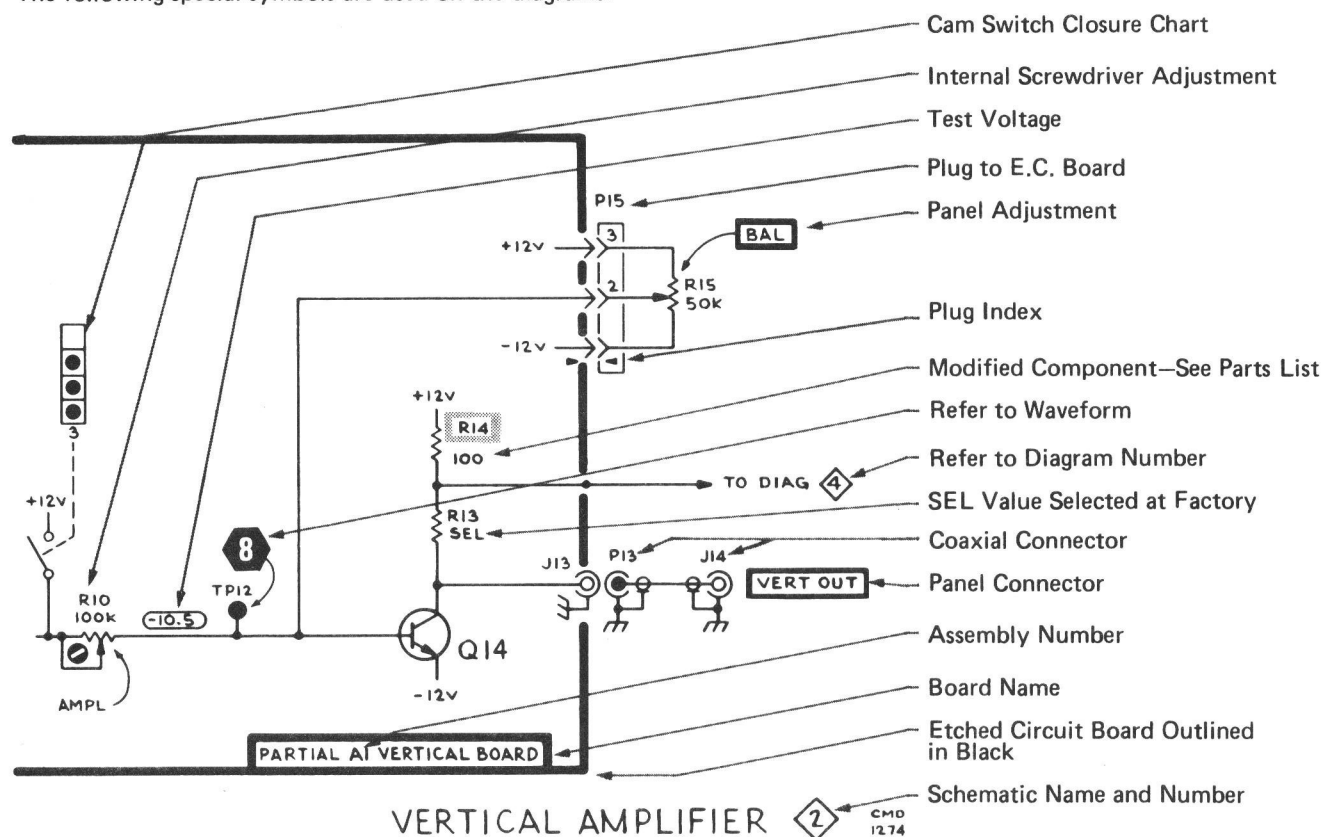
Symbols used on the diagrams are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	H	Heat dissipating device (heat sink, heat radiator, etc.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse	R	Resistor, fixed or variable		
FL	Filter				

The following special symbols are used on the diagrams:



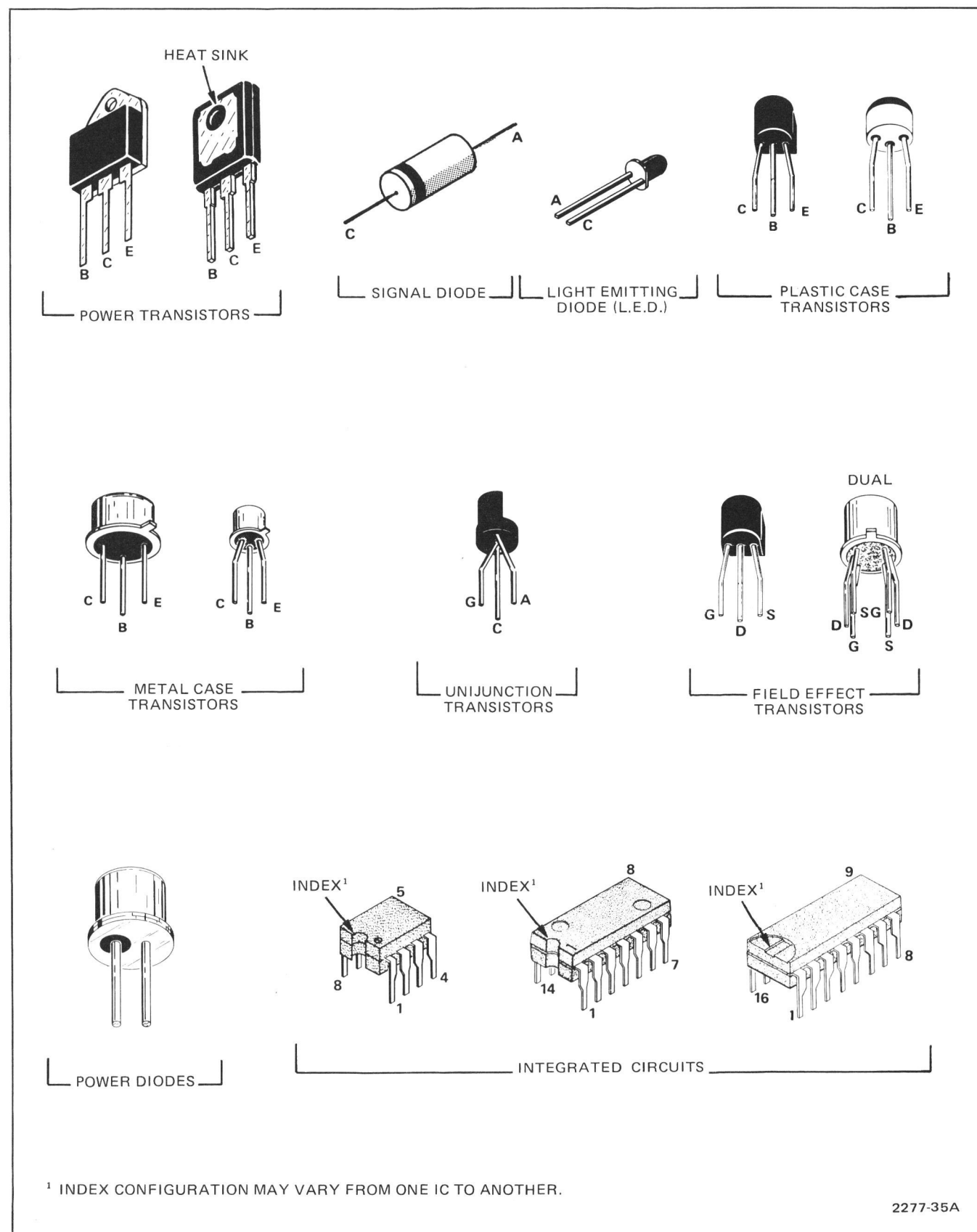


Figure 8-1. Semiconductor lead configurations.

REV. A DEC 1978

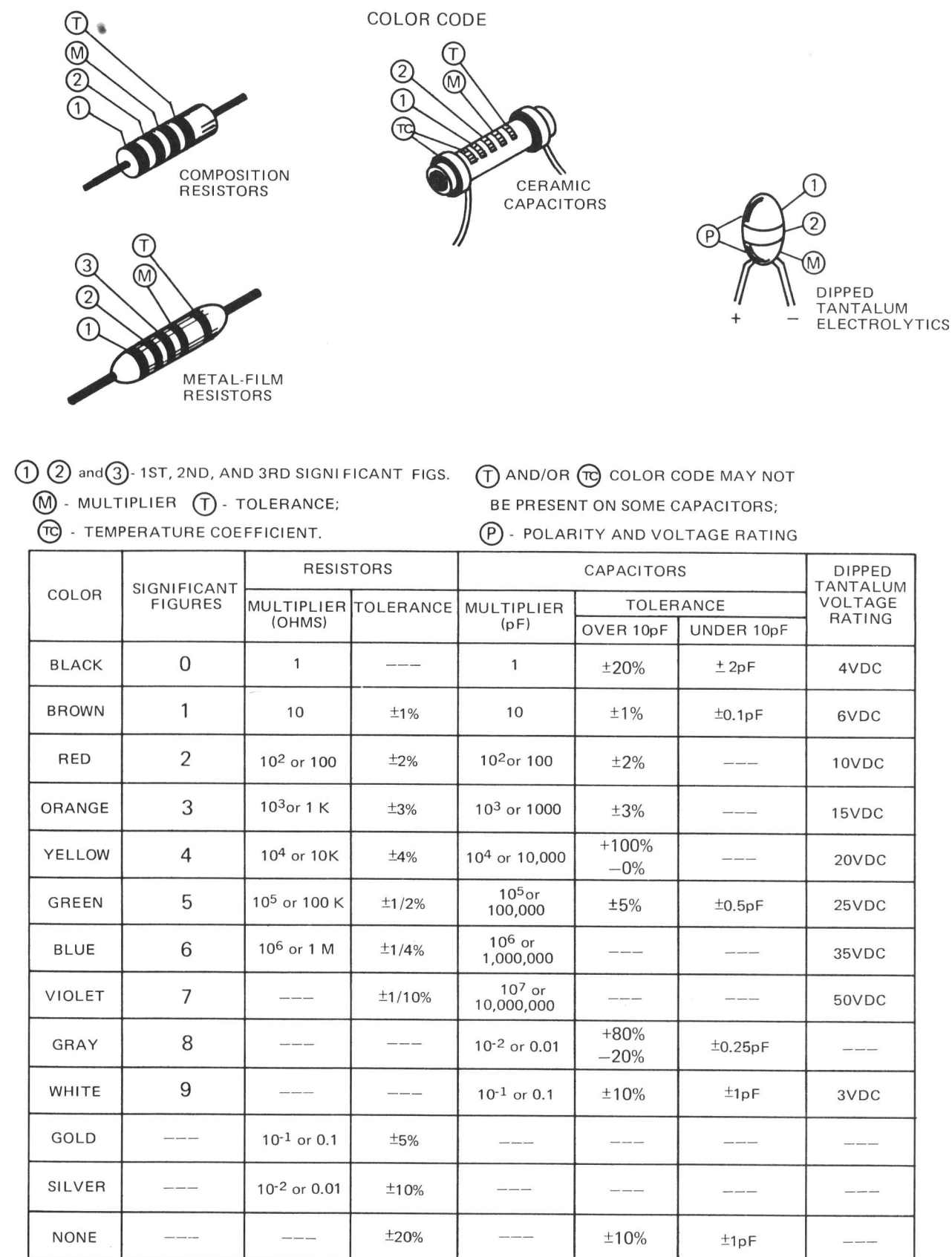


Figure 8-2. Capacitor and Resistor value identification.

Symbol Definitions

- 1 High Level
- 0 Low Level
- X Don't Care
- Positive Transition
- Negative Transition
- CL Clock Level Change
- One High Level Pulse
- One Low Level Pulse

4013 (156-0366-00)
DUAL 'D' TYPE FLIP-FLOP
 (U1712, U1623, U1023)

CL ^A	D	R	S	Q	\bar{Q}
	0	0	0	0	1
	1	0	0	1	0
	X	0	0	Q	\bar{Q}
X	X	1	0	0	1
X	X	0	1	1	0
X	X	1	1	1	1

NO CHANGE

4016 (156-0289-00)
4066 (156-0644-00)
QUAD BILATERAL SWITCH
 (U741, U925, U1223, U1313
 U1343, U1452, U1632)

CONTROL	SWITCH
1	closed
0	open

4027 (156-0525-00)
DUAL J-K MASTER SLAVE FLIP-FLOP
 (U951, U1025)

PRESENT STATE					CL ^A	NEXT STATE	
INPUTS		OUTPUT		OUTPUTS			
J	K	S	R	Q		Q	\bar{Q}
1	X	0	0	0		1	0
X	0	0	0	1		1	0
0	X	0	0	0		0	1
X	1	0	0	1		0	1
X	X	0	0	X		←NO CHANGE	
X	X	1	0	X	X	1	0
X	X	0	1	X	X	0	1
X	X	1	1	X	X	1	1

4028 (156-0756-00)
BCD-to-DECIMAL DECODER
 (U1146)

D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1

4051 (156-0513-00)
MULTIPLEXER/DEMULTIPLEXER
 (U592, U1175)

INPUT STATES				"ON" CHANNELS
INHIBIT	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	X	X	X	NONE

74C221 (156-0750-00)
DUAL MONSTABLE MULTIVIBRATOR
 (U1179, U1312, U1326,
 U1342, U1633, U1706)

INPUTS			OUTPUTS	
CLEAR	A	B	Q	\bar{Q}
0	X	X	0	1
X	1	X	0	1
X	X	0	0	1
1	0			
1		1		

Note: Pins 1 and 9 are 'A' contacts, pins 2 and 10 are 'B' contacts.

2277 64

2277 64

4518 (156-0752-00)
DUAL UP COUNTERS
(U1021)

CLOCK	ENABLE	RESET	ACTION
	1	0	Increment Counter
0		0	Increment Counter
	X	0	No Change
X		0	No Change
	0	0	No Change
1		0	No Change
X	X	1	Q1 thru Q4 = 0

4024 (156-0523-00)
7-STAGE BINARY COUNTER
(U736)

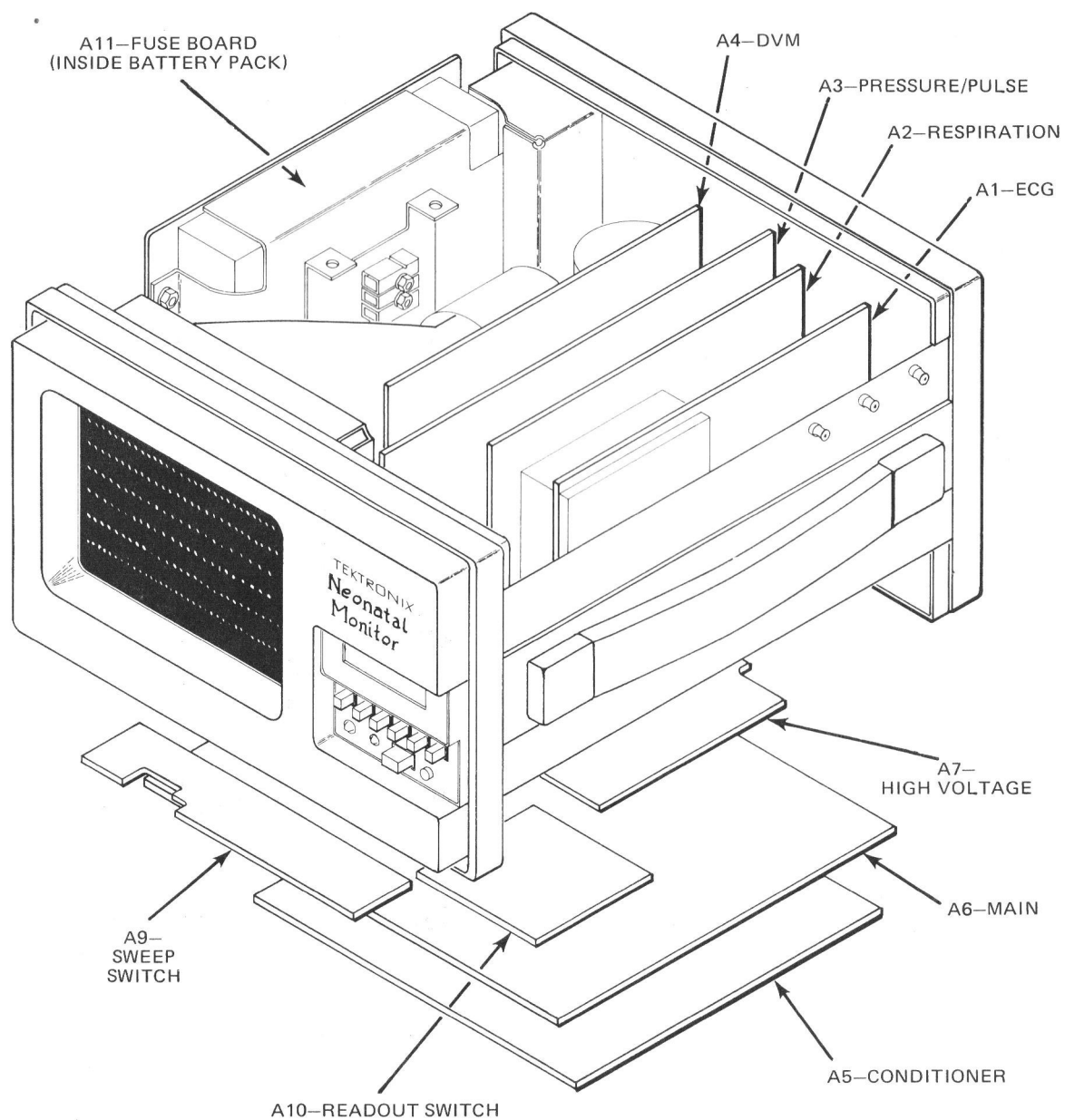
CLOCK	RESET	STATE
0	0	No Change
0	1	All Outputs Low
1	0	No Change
1	1	All Outputs Low
	0	No Change
	1	All Outputs Low
	0	Advance One Count
	1	All Outputs Low

DM8880 (156-0284-00)
DECODER/DRIVER
(U975)

(SYMBOL
IDENTIFICATION)

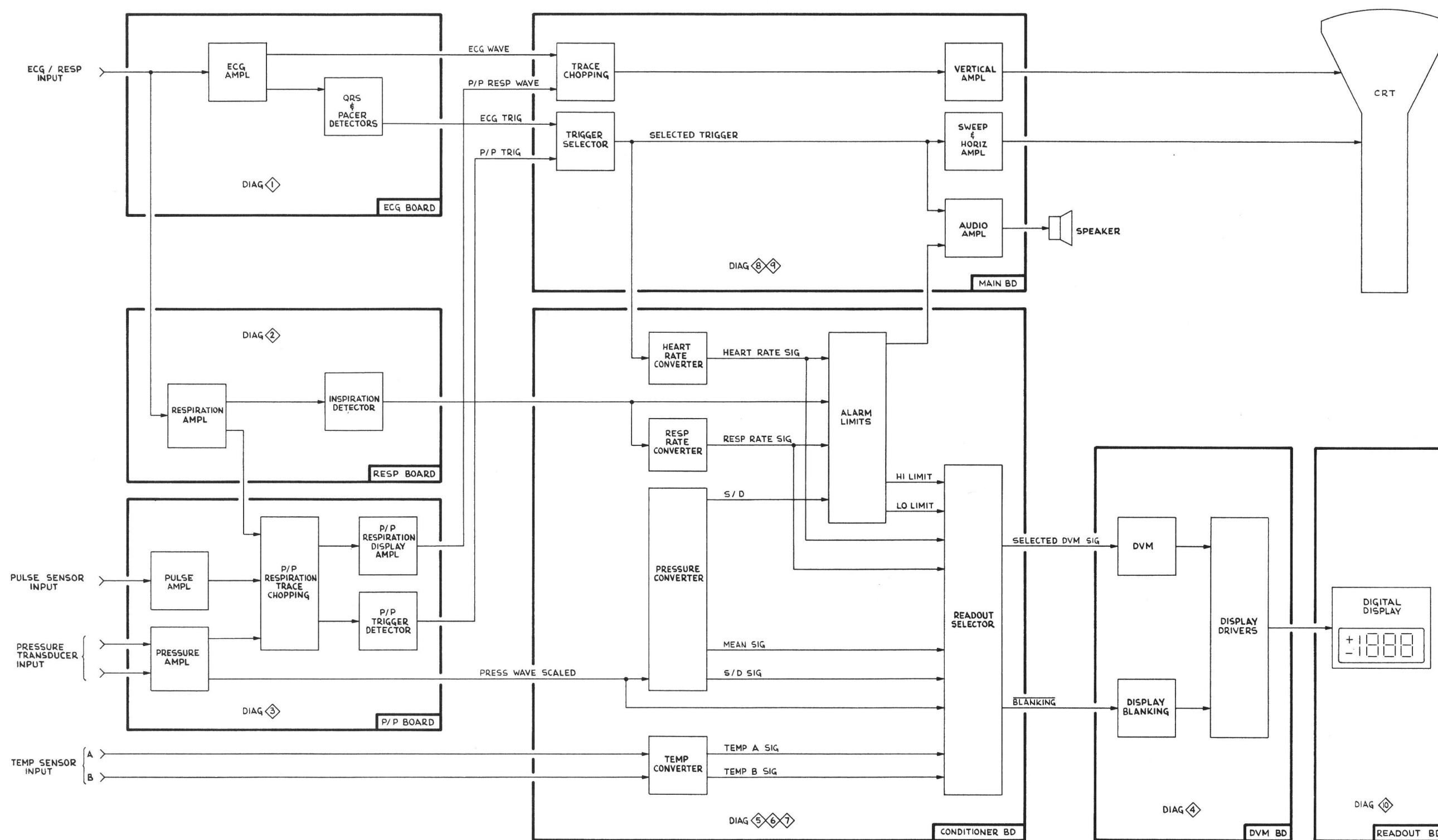
DECIMAL OR FUNCTION	RB1	D	C	B	A	B1/RB0	a	b	c	d	e	f	g	DISPLAY
0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
1	X	0	0	0	1	1	1	0	0	1	1	1	1	1
2	X	0	0	1	0	1	0	0	1	0	0	1	0	2
3	X	0	0	1	1	1	0	0	0	0	1	1	0	3
4	X	0	1	0	0	1	1	0	0	1	1	0	0	4
5	X	0	1	0	1	1	0	1	0	0	1	0	0	5
6	X	0	1	1	0	1	0	1	0	0	0	0	0	6
7	X	0	1	1	1	1	0	0	0	1	1	1	1	7
8	X	1	0	0	0	1	0	0	0	0	0	0	0	8
9	X	1	0	0	1	1	0	0	0	0	1	0	0	9
10	X	1	0	1	0	1	0	0	0	1	0	0	0	A
11	X	1	0	1	1	1	1	1	0	0	0	0	0	b
12	X	1	1	0	0	1	0	1	1	0	0	0	1	C
13	X	1	1	0	1	1	1	0	0	0	0	1	0	d
14	X	1	1	1	0	1	0	1	1	0	0	0	0	E
15	X	1	1	1	1	1	0	1	1	1	0	0	0	F
B1	X	X	X	X	X	0	1	1	1	1	1	1	1	
RB1	0	0	0	0	0	0	1	1	1	1	1	1	1	

2277 65



2277-17

Figure 8-4. Circuit board locations.



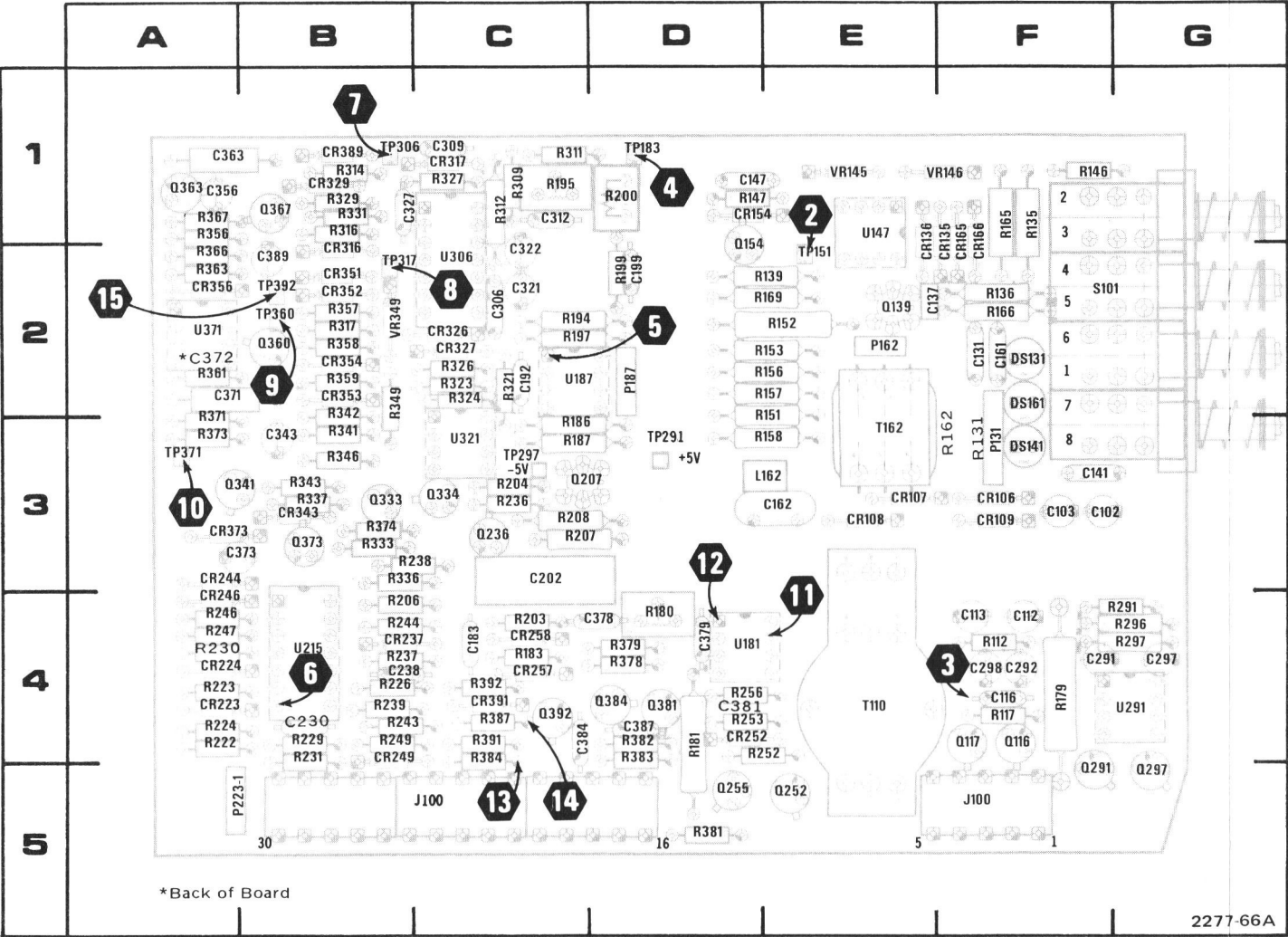
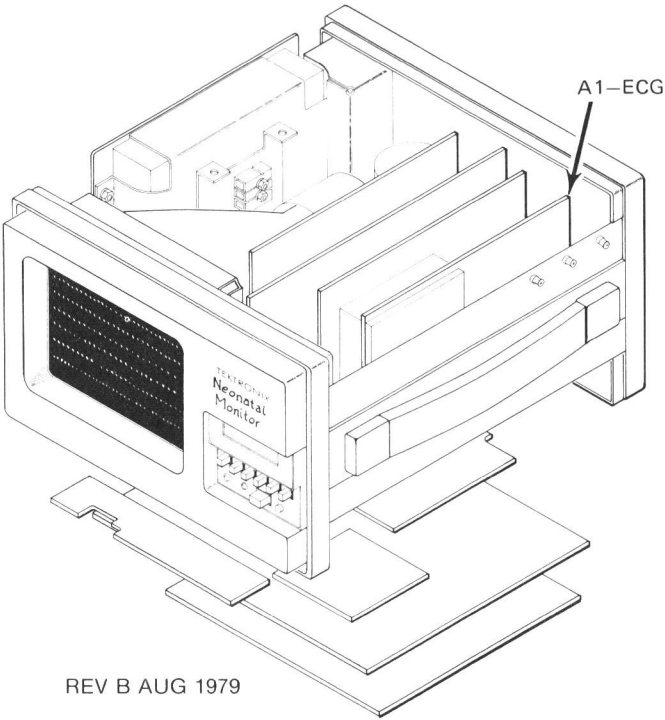
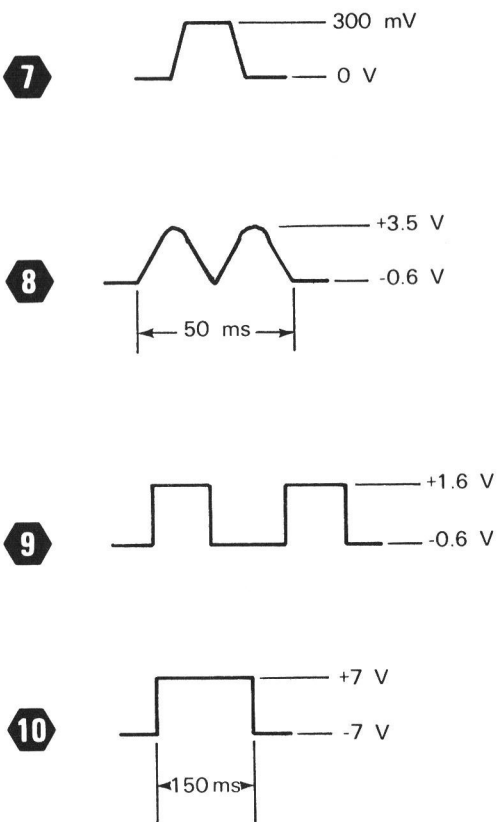


Figure 8-5. A1-ECG board component locations.

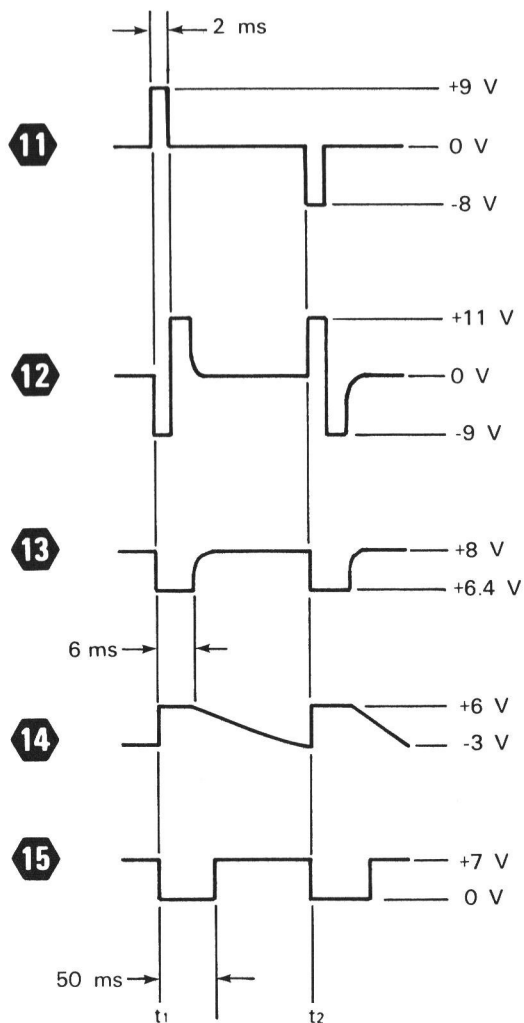
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C102	3F	CR106	3F	L162	3E	R156	2D	R252	4D	R378	4D
C103	3F	CR107	3E			R157	2D	R253	4D	R379	4D
C112	4F	CR108	3E	P131	3F	R158	3E	R256	4D	R381	5D
C113	4F	CR109	3F	P162	2E	R162	3F	R291	4G	R382	4D
C116	4F	CR135	1F	P187	2D	R165	1F			R383	4D
C131	2F	CR136	1E	P223-1	5A	R166	2F	R296	4G	R384	4C
C137	2E	CR154	1D			R169	2D	R297	4G	R387	4C
C141	3F	CR165	1F	Q116	4F	R179	4F	R309	1C	R391	4C
C147	1D	CR166	1F	Q117	4F	R180	4D	R311	1C	R392	4C
C161	2F	CR223	4A	Q139	2E	R181	4D	R312	1C		
C162	3E	CR224	4A	Q154	1D	R183	4C	R314	1B	S101	2F
C183	4C	CR237	4B	Q207	3C	R186	2C	R316	1B		
C192	2C	CR244	3A	Q236	3C	R187	3C	R317	2B		
C199	2D	CR246	3A	Q252	5E	R194	2C	R321	2C	T110	4E
C202	3C	CR249	4B	Q255	5D	R195	1C	R323	2C	T162	3E
C230	4B	CR252	4D	Q291	4F	R197	2C	R324	2C		
C238	4B	CR257	4C	Q297	4G	R199	2D	R326	2C	TP151	2E
C291	4F	CR258	4C	Q333	3B	R200	1D	R327	1C	TP183	1D
C292	4F	CR316	1B	Q334	3C	R203	4C	R329	1B	TP291	3D
C297	4G	CR317	1C	Q341	3A	R204	3C	R331	1B	TP297	3C
C298	4F	CR326	2C	Q360	2B	R206	4B	R333	3B	TP306	1B
C306	2C	CR327	2C	Q363	1A	R207	3C	R336	3B	TP317	2B
C309	1C	CR329	1B	Q367	1B	R208	3C	R337	3B	TP360	2B
C312	1C	CR343	3B	Q373	3B	R222	4A	R341	3B	TP371	3A
C321	2C	CR351	2B	Q381	4D	R223	4A	R342	2B	TP392	2B
C322	1C	CR352	2B	Q384	4D	R224	4A	R343	3B		
C327	1B	CR353	2B	Q392	4C	R226	4B	R346	3B	U147	1E
C343	3B	CR354	2B			R229	4B	R349	2B	U181	4D
C356	1A	CR355	2A			R230	4A	R356	1A	U187	2C
C363	1A	CR373	3A	R112	4F	R231	4B	R357	2B	U215	4B
C371	2A	CR389	1B	R117	4F	R236	3C	R358	2B	U291	4G
C372	2A	CR391	4C	R131	3F	R237	4B	R359	2B	U306	2C
C373	3A			R135	1F	R238	3B	R361	2A	U321	3C
C378	4D			R136	2F	R239	4B	R363	2A	U371	2A
C379	4D	DS131	2F	R139	2D	R243	4B	R366	2A		
C381	4D	DS141	3F	R146	1F	R244	4B	R367	1A	VR145	1E
C384	4C	DS161	2F	R147	1D	R246	4A	R371	2A	VR146	1F
C387	4D			R151	2D	R247	4A	R373	3A	VR349	2B
C389	2B	J100	5C	R152	2E	R249	4B	R374	3B		
				R153	2D						



ECG TEST PULSE WAVEFORMS:



PACER TEST PULSE WAVEFORMS:



VOLTAGE AND WAVEFORM CONDITIONS

Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground unless noted otherwise.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms.

413 SETTINGS AND INPUT

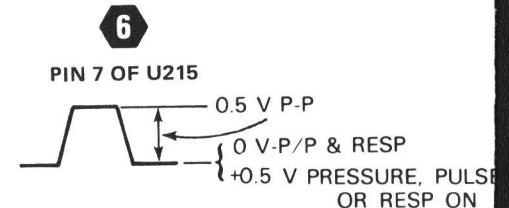
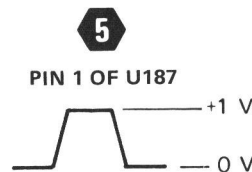
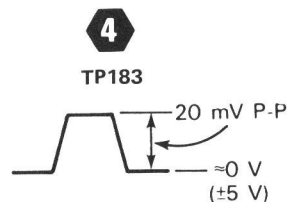
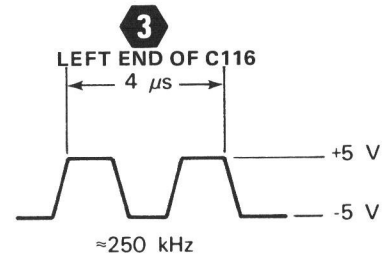
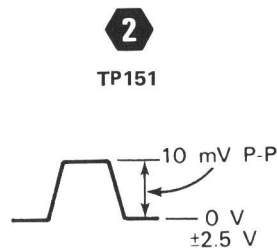
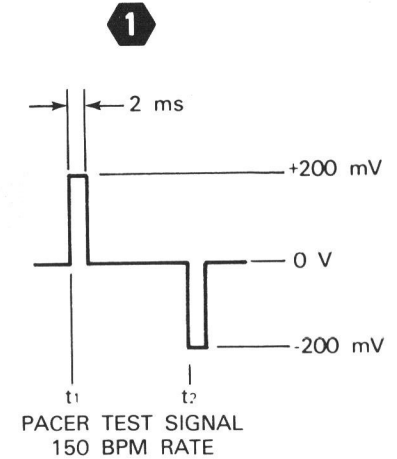
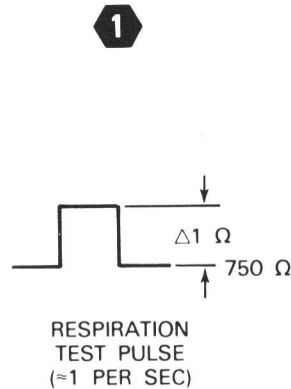
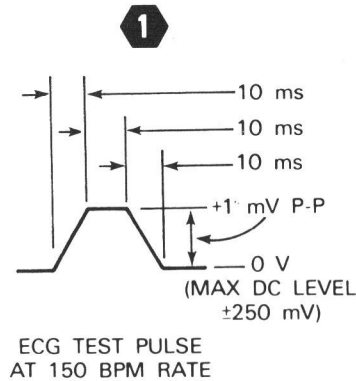
ECG Lead Selector
ECG SIZE
ECG/RESPIRATION INPUT

II
Midrange (index mark)
ECG:

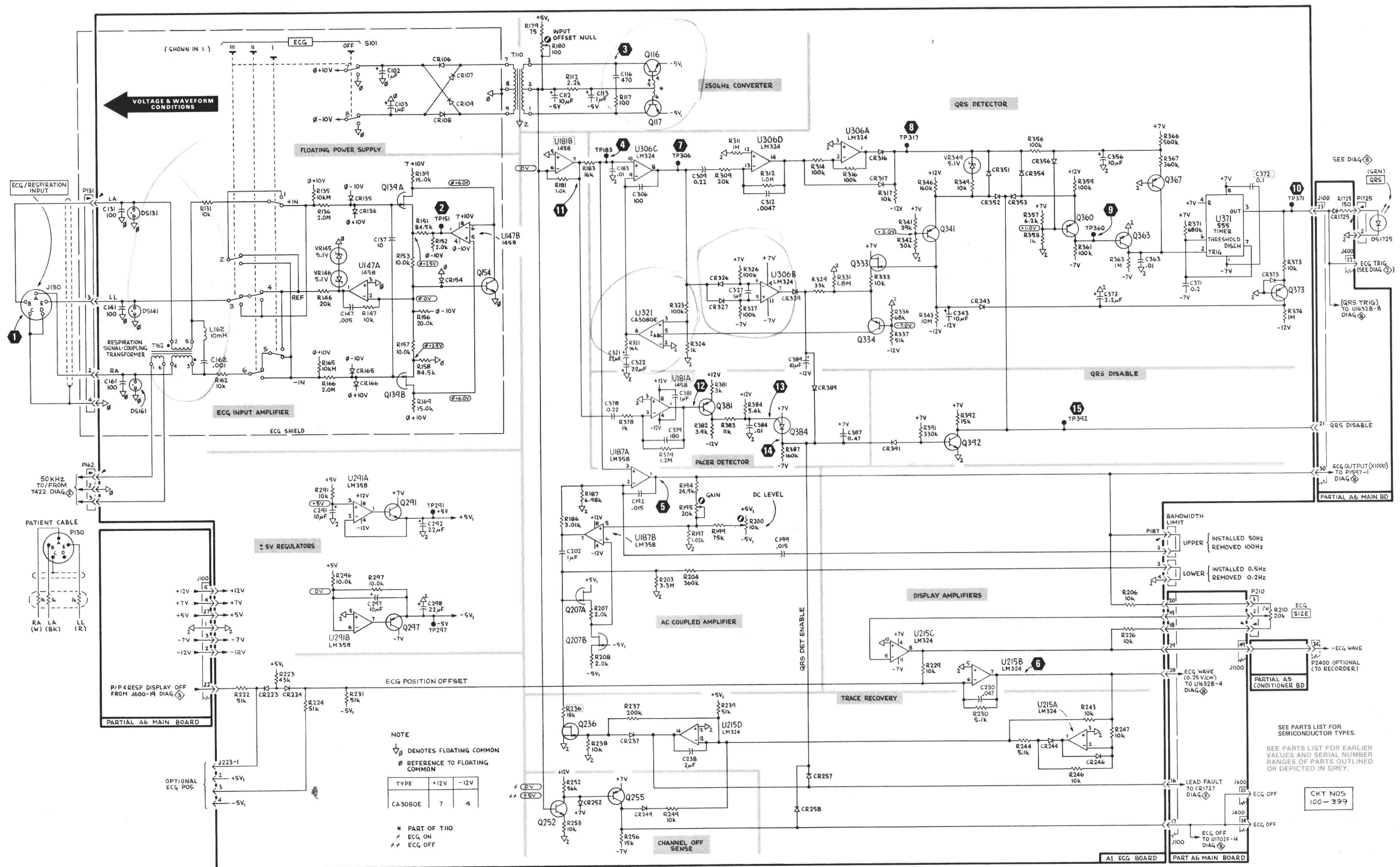
a. Pin A shorted to pin B. Test pulse applied between LL (pin E) and RA (pin A).

b. For pacer test, substitute pacer test pulse for ECG test pulse.

RESPIRATION: Test pulse applied between RA (pin A) and LA (pin B).



WAVEFORMS
CONTINUED



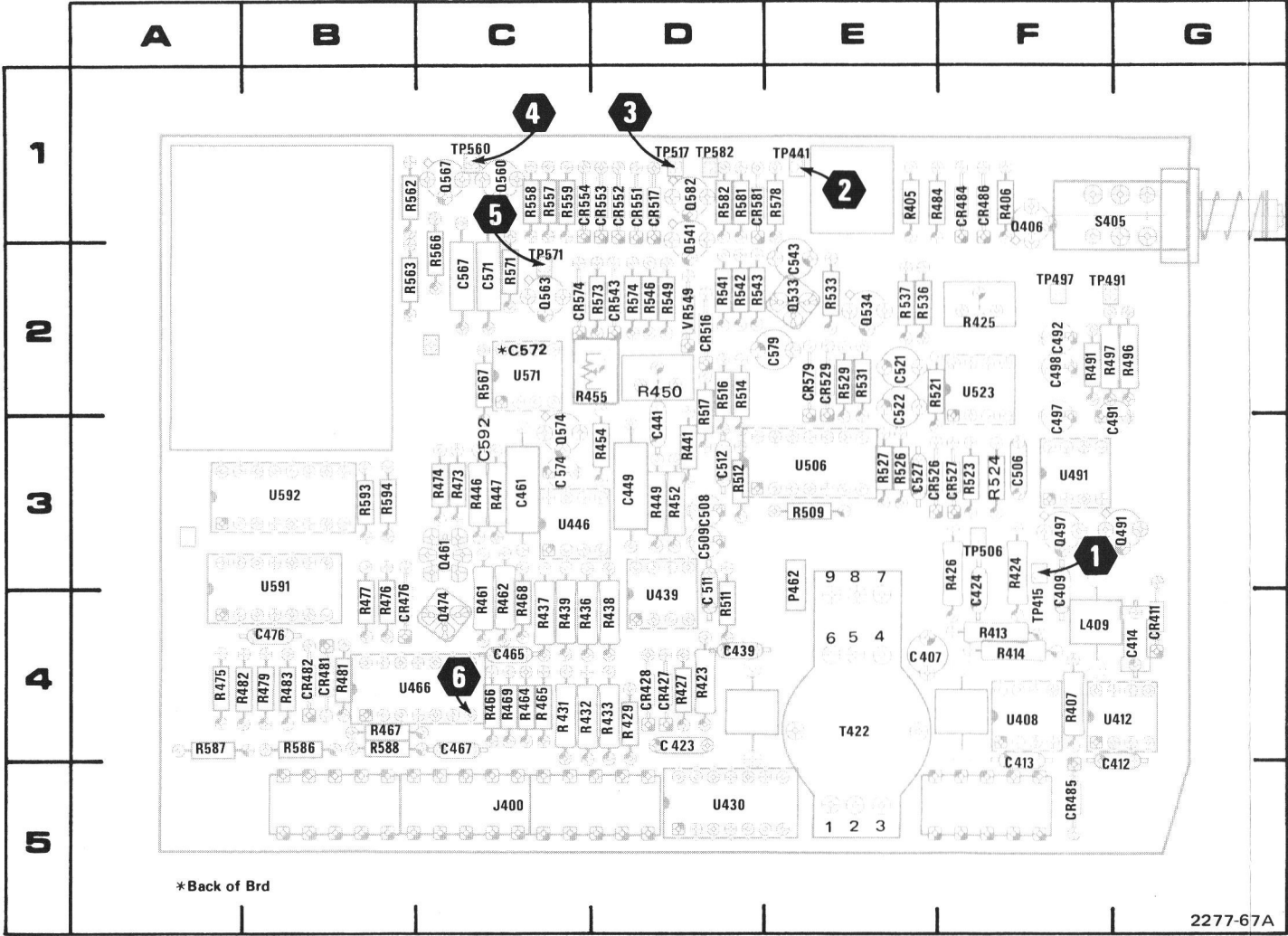
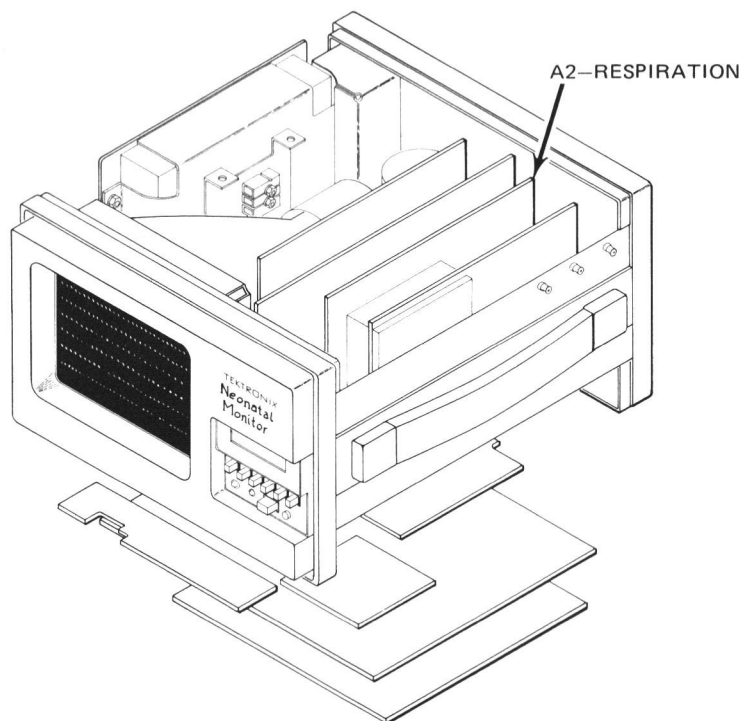


Figure 8-6. A2-Respiration board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C407	3E	C592	3C	Q497	3F	R454	3D	R527	3E	S405	1G
C409	3F	CR411	4G	Q533	2E	R455	2C	R529	2E	T422	3E
C412	4G	CR427	4D	Q534	2E	R461	4C	R524	3F		
C413	4F	CR428	4D	Q541	1D	R462	4C	R531	2E	TP415	3F
C414	4G	CR476	3B	Q560	1C	R464	4C	R533	2E	TP441	1E
C423	4D	CR481	4B	Q563	2C	R465	4C	R536	2E	TP491	2F
C424	3F	CR482	4B	Q567	1C	R466	4C	R537	2E	TP497	2F
C439	4D	CR484	1F	Q574	3C	R467	4B	R541	2D	TP506	3F
C441	2D	CR485	5F	Q582	1D	R468	4C	R542	2D	TP517	1D
C449	3D	CR486	1F	R405	1E	R469	4C	R543	2D	TP560	1C
C461	3C	CR516	2D	R406	1F	R473	3C	R546	2D	TP571	2C
C465	4C	CR517	1D	R407	4F	R474	3C	R549	2D	TP582	1D
C467	4C	CR526	3E	R413	4F	R475	4A	R557	1C		
C476	4B	CR527	3F	R414	4F	R476	3B	R558	1C		
C491	2F	CR529	2E	R423	4D	R477	3B	R559	1C	U408	4F
C492	2F	CR543	2D	R424	3F	R479	4B	R562	1B	U412	4G
C497	2F	CR551	1D	R425	2F	R481	4B	R563	2B	U430	5D
C498	2F	CR552	1D	R426	3F	R482	4A	R566	1C	U446	3C
C506	3F	CR553	1D	R427	4D	R483	4B	R567	2C	U466	4B
C508	3D	CR554	1C	R429	4D	R484	1E	R571	2C	U491	3F
C509	3D	CR574	2C	R431	4C	R491	2F	R573	2C	U506	3E
C511	3D	CR579	2E	R432	4C	R496	2G	R574	2D	U523	2F
C512	3D	CR581	1D	R433	4D	R497	2F	R578	1E	U571	2C
C521	2E	J600	5C	R436	4C	R509	3E	R581	1D	U439	3D
C522	2E	L409	4F	R437	4C	R511	4D	R582	1D		
C527	3E			R438	4D	R512	3D	R586	4B	VR549	2D
C533	2E	P462	3E	R439	4C	R514	2D	R587	4A		
C543	2E			R441	3D	R516	2D	R588	4B		
C567	2C	Q406	1F	R446	3C	R517	2D	R591	3B		
C571	2C	Q461	3C	R447	3C	R521	2E	R592	3B		
C572	2C	Q474	4C	R449	3D	R523	3F	R593	3B		
C574	3C	Q491	3G	R452	3D	R526	3E	R594	3B		
C579	2E										



VOLTAGE AND WAVEFORM CONDITIONS

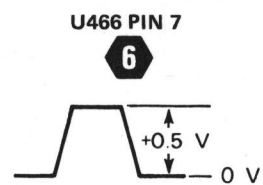
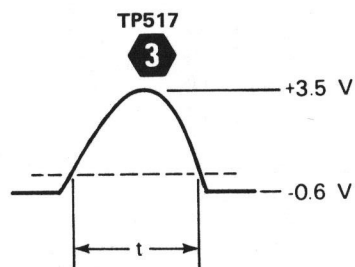
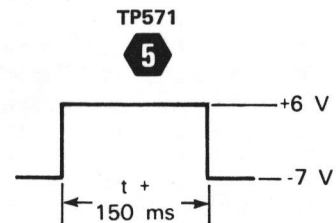
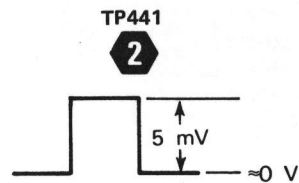
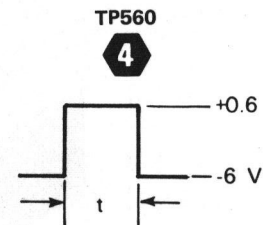
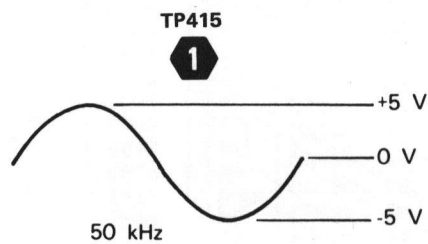
Voltages are design center and may vary from measured values. Voltages are referred to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms.

413 CONTROL SETTINGS AND INPUTS FOR WAVEFORMS

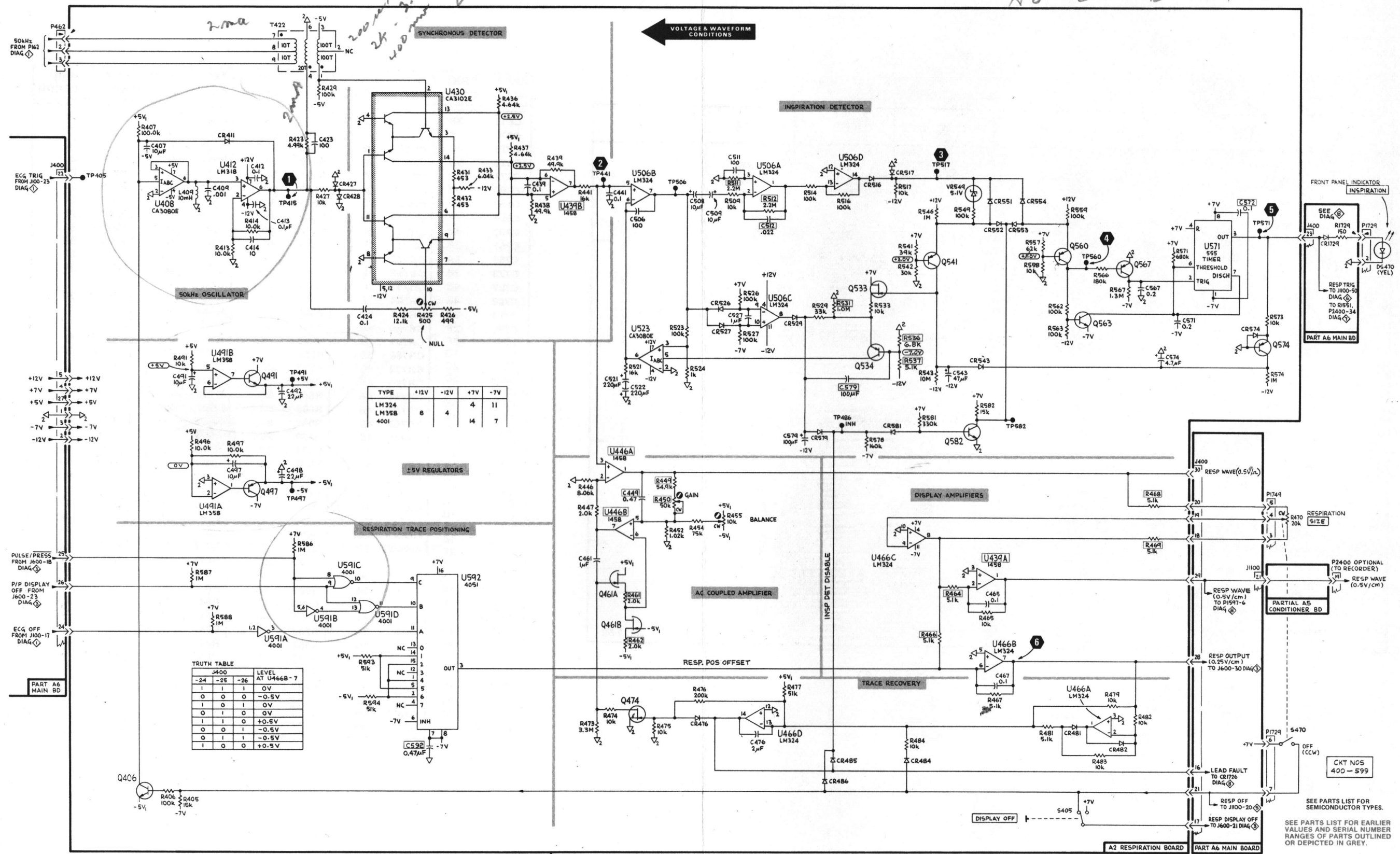
RESPIRATION DISPLAY OFF
RESPIRATION SIZE
ECG/RESPIRATION INPUT

OUT (ON)
Midrange (index mark)
Respiration Test Pulse
(See Waveform 1
on diagram 1)



DC Level Depends on U592 Input Logic
See TRUTH TABLE on Schematic

NO CVA DET
NO LOW ECG DET



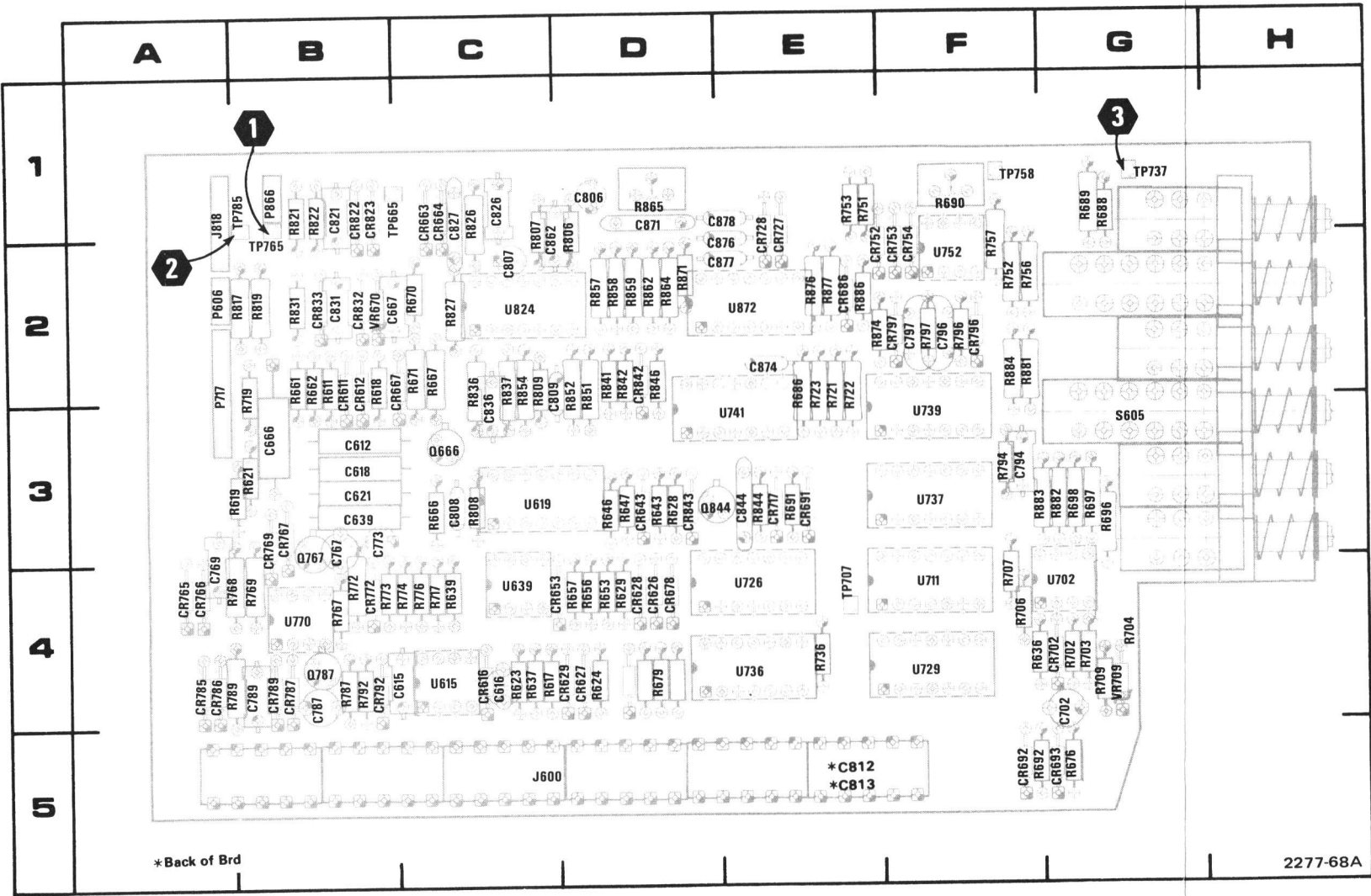
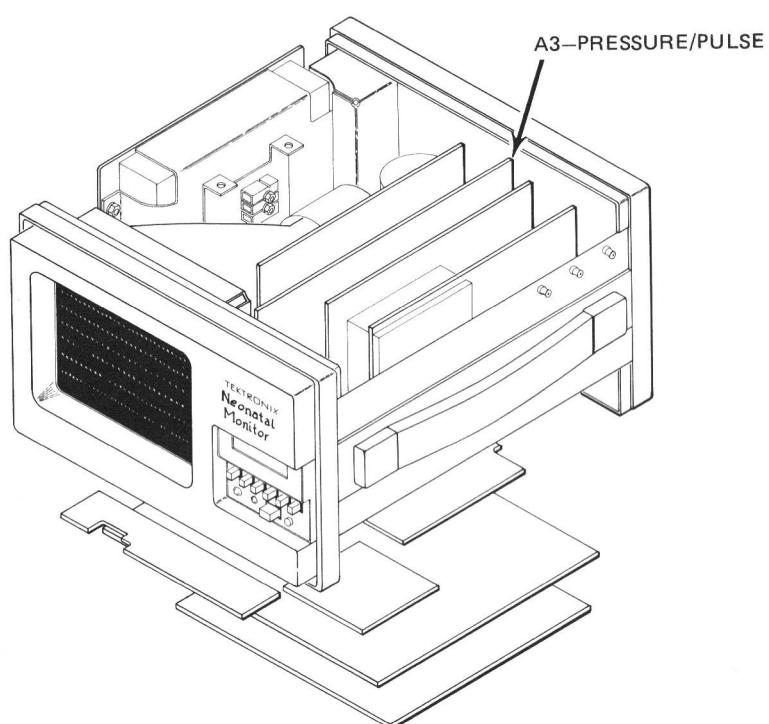


Figure 8-7. A3-Pressure/Pulse board component locations.

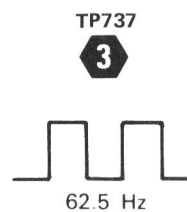
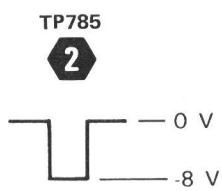
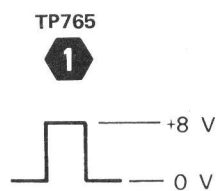
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C612	3B	CR667	2B	R611	2B	R721	2E	R862	2D
C615	4B			R617	4C	R722	2E	R864	2D
C616	4C	CR678	4D	R618	2B	R723	2E	R865	1D
C618	3B	CR686	2E	R619	3B	R736	4E	R871	2D
C621	3B	CR691	3E	R621	3B	R751	1E	R874	2E
C639	3B	CR692	5F	R622	2B	R752	2F	R876	2E
C666	3B	CR693	5G	R623	4C	R753	1E	R877	2E
C667	2B	CR702	4G	R624	4D	R756	2F	R881	2F
C702	4G	CR717	3E	R628	3D	R757	1F	R882	3G
C767	3B	CR727	1E	R629	4D	R767	4B	R883	3F
C769	3A	CR728	1E	R636	4F	R768	4A	R884	2F
C773	3B	CR752	1E	R637	4C	R769	4B	R886	2E
C787	4B	CR753	1F	R639	4C	R772	4B		
C789	4B	CR754	1F	R643	3D	R773	4B	S605	3G
C794	3F	CR765	4A	R646	3D	R774	4C		
C796	2F	CR766	4A	R647	3D	R776	4C	TP665	1C
C797	2F	CR767	3B	R653	4D	R787	4B	TP707	4E
C806	1D	CR769	3B	R656	4D	R789	4A	TP737	1G
C807	2C	CR772	4B	R657	4D	R792	4B	TP758	1F
C808	3C	CR785	4A	R661	2B	R794	3F	TP765	1B
C809	2C	CR786	4A	R662	2B	R796	2F	TP785	1B
C812	5E	CR787	4B	R666	3C	R797	2F		
C813	5E	CR789	4B	R667	2C	R806	1D	U615	4C
C821	1B	CR792	4B	R670	2C	R807	1C	U619	3C
C826	1C	CR796	2F	R671	2C	R808	3C	U639	4C
C827	1C	CR797	2F	R676	5G	R809	2C	U702	4G
C831	2B	CR822	1B	R679	4D	R817	2B	U711	4F
C836	2C	CR823	1B	R686	2E	R819	2B	U726	4E
C844	3E	CR832	2B	R688	1G	R821	1B	U729	4F
C862	1C	CR833	2B	R689	1G	R822	1B	U736	4E
C871	1D	CR842	2D	R690	1F	R826	1C	U737	3F
C874	2E	CR843	3D	R691	3E	R827	2C	U739	3F
C876	1E			R692	5F	R831	2B	U741	3E
C877	2E			R696	3G	R836	2C	U752	2F
C878	1E	J600	5C	R697	3G	R837	2C	U770	4B
		J818	1A	R698	3G	R841	2D	U824	2C
CR611	2B			R702	4G	R842	2D	U872	2E
CR612	2B	P606	2A	R703	4G	R844	3E		
CR616	4C	P717	2A	R704	4G	R846	2D	VR670	2B
CR626	4D	P866	1B	R706	4F	R851	2D	VR709	4G
CR627	4D			R707	4F	R852	2D		
CR628	4D			R709	4G	R854	2C		
CR629	4D			R717	4C	R857	2D		
CR643	3D	Q666	3C	R719	2B	R858	2D		
CR653	4C	Q767	3B			R859	2D		
CR663	1C	Q787	4B						
CR664	1C	Q844	3D						

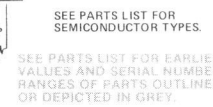


VOLTAGE AND WAVEFORM CONDITIONS

Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms.





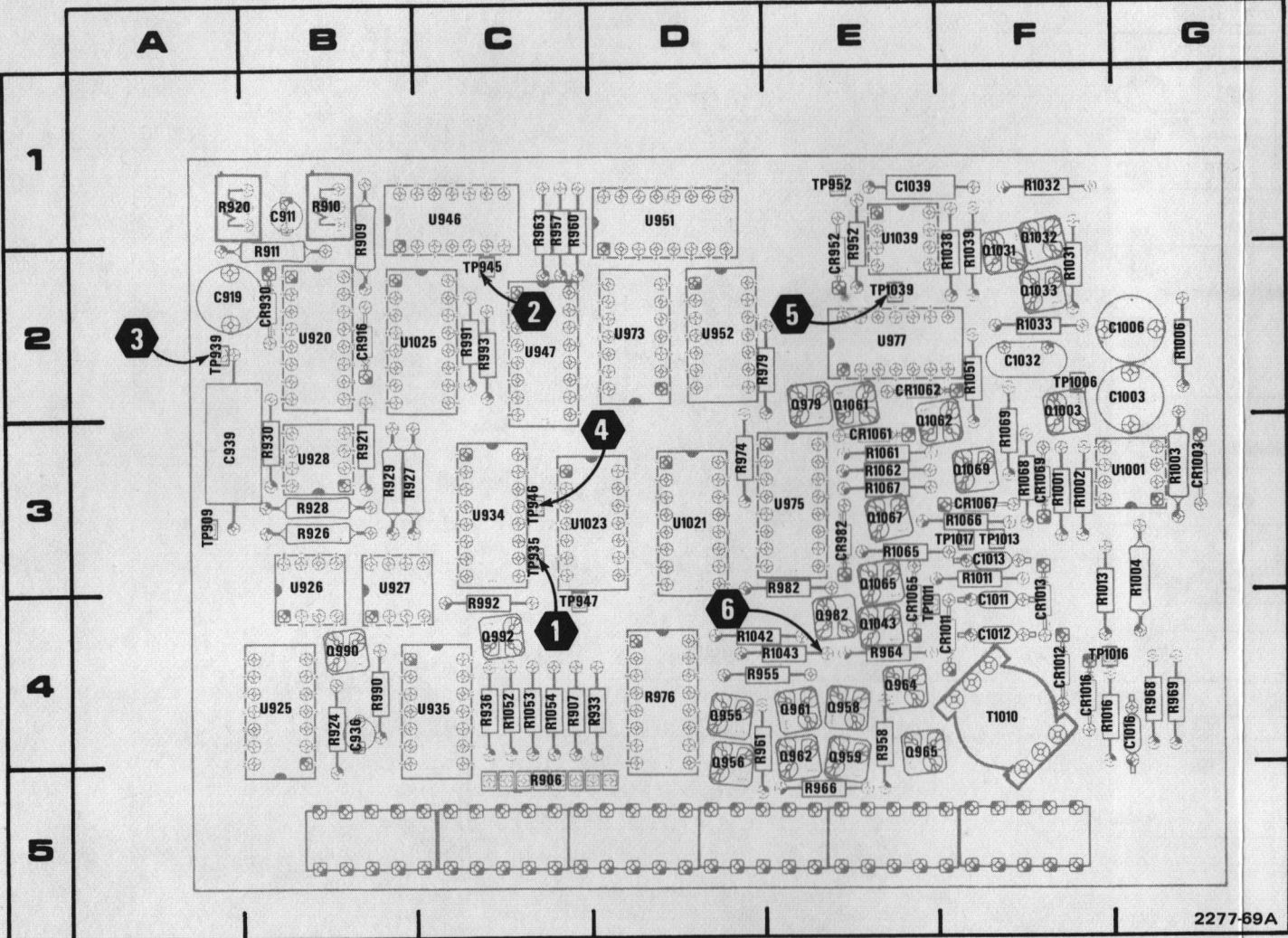
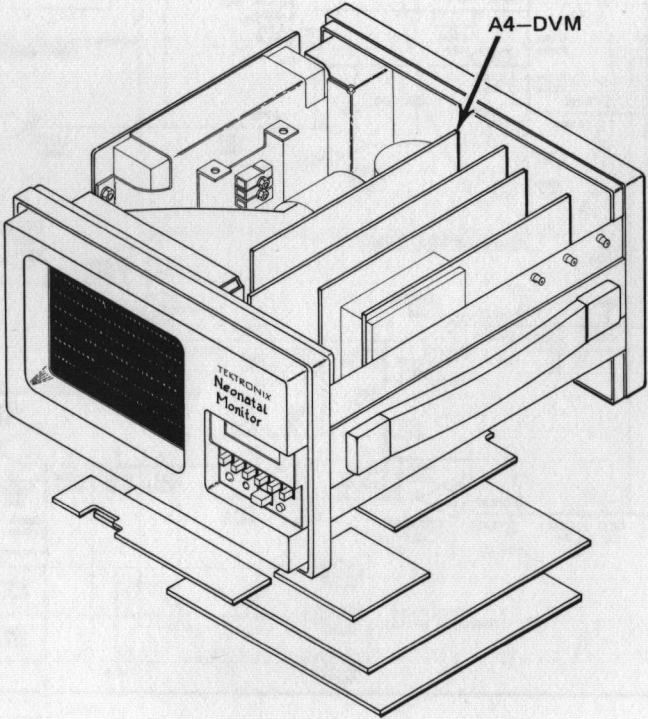


Figure 8-8. A4-DVM board component locations.

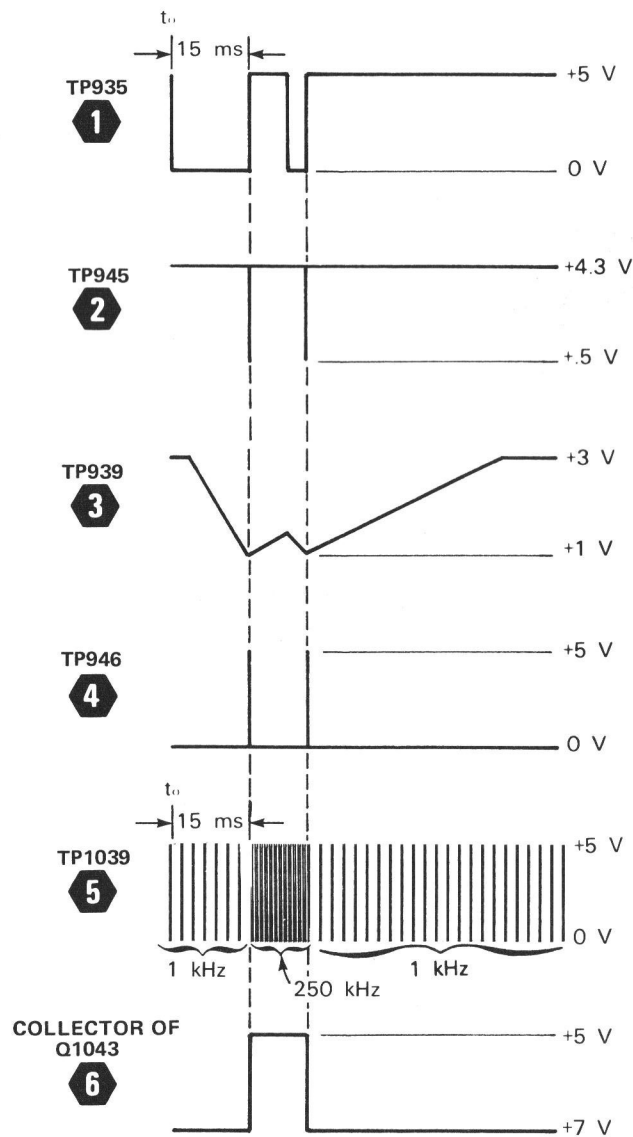
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C911	1B	CR1069	3F	R907	4C	R969	4G	R1043	4D	TP1016	4F
C919	2A			R909	1B	R974	3D	R1051	2F	TP1017	3F
C936	4B	Q955	4D	R910	1B	R976	4D	R1052	4C	TP1039	2E
C939	3A	Q956	4D	R911	2B	R979	2D	R1053	4C		
C1003	2G	Q958	4E	R920	1A	R982	3E	R1054	4C	U920	2B
C1006	2G	Q959	4E	R921	3B	R990	4B	R1061	3E	U925	4B
C1011	4F	Q961	4E	R924	4B	R991	2C	R1062	3E	U926	3B
C1012	4F	Q962	4E	R926	3B	R992	4C	R1065	3E	U927	3B
C1013	3F	Q964	4E	R927	3B	R993	2C	R1066	3F	U928	3B
C1016	4G	Q965	4E	R928	3B	R1001	3F	R1067	3E	U934	3C
C1032	2F	Q979	2E	R929	3B	R1002	3F	R1068	3F	U935	4C
C1039	1E	Q982	4E	R930	3B	R1003	3G	R1069	3F	U946	1C
		Q990	4B	R933	4C	R1004	3G			U947	2C
CR930	2B	Q992	4C	R936	4C	R1006	2G	T1010	4F	U951	1C
CR952	2E	Q1003	2F	R952	2E	R1011	3F	TP909	3A	U952	2D
CR982	3E	Q1032	1F	R955	4D	R1013	3F	TP935	3C	U973	2D
CR1003	3G	Q1033	2F	R957	1C	R1016	4F	TP939	2A	U975	3E
CR1011	4F	Q1043	4E	R958	4E	R1031	2F	TP945	2C	U977	2E
CR1012	4F	Q1061	2E	R960	1C	R1032	1F	TP946	3C	U1001	3G
CR1013	4F	Q1062	2E	R961	4D	R1033	2F	TP947	4C	U1021	3D
CR1016	4F	Q1065	3E	R963	1C	R1038	2F	TP952	1E	U1023	3C
CR1061	3E	Q1067	3E	R964	4E	R1039	2F	TP1006	2F	U1025	2B
CR1062	2E	Q1069	3F	R966	5E	R1039	2F	TP1013	3F	U1039	1E
CR1067	3F	R906	5C	R968	4G	R1042	4D				



VOLTAGE AND WAVEFORM CONDITIONS

Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms. All waveforms are time related. Times indicated are with respect to t_0 . The test oscilloscope is triggered on -slope from TP935. Digital readout displaying temperature of about 113°F.





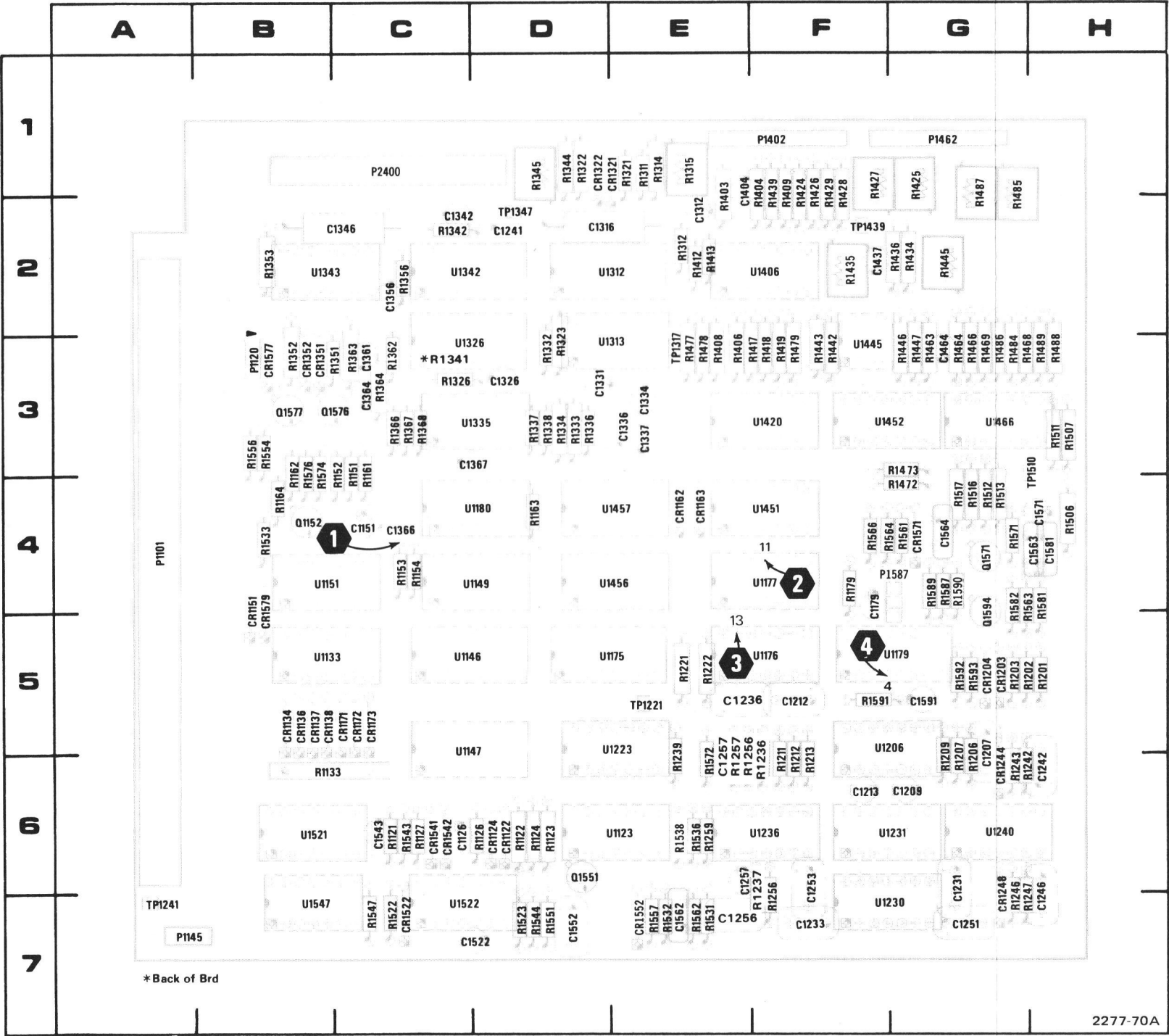
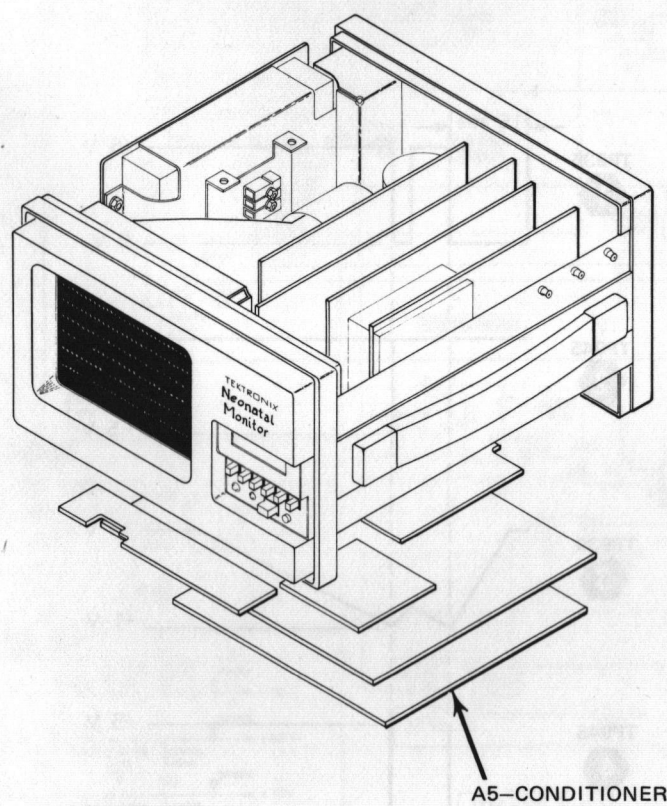


Figure 8-9. A5-Conditioner board component locations.

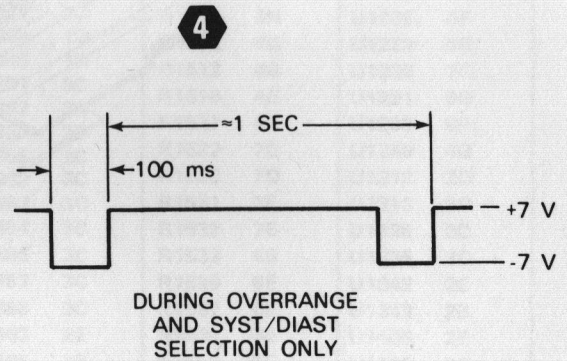
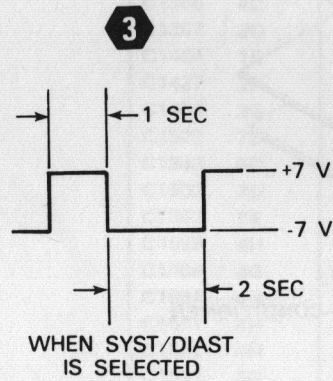
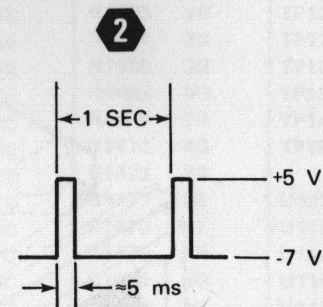
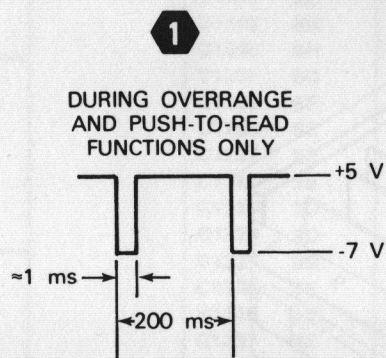
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C1151	4C	CR1173	5C	R1216	5F	R1429	1F	R1574	3B
C1179	4F	CR1203	5G	R1221	5E	R1434	2G	R1576	3B
C1207	5G	CR1204	5G	R1222	5E	R1435	2F	R1581	4H
C1209	6G	CR1243	6G	R1236	7F	R1436	2G	R1582	4G
C1212	5F	CR1248	6G	R1237	7F	R1439	1F	R1587	4G
C1213	6F	CR1321	1E	R1239	5E	R1442	3F	R1589	4G
C1231	7G	CR1322	1D	R1242	6G	R1443	3F	R1590	4G
C1233	7F	CR1351	3B	R1243	6G	R1445	2G	R1591	5F
C1236	7E	CR1352	3B	R1246	6G	R1446	3G	R1592	5G
		CR1522	7C	R1247	6G	R1447	3G	R1593	5G
C1241	2C	CR1541	6C	R1256	5E	R1463	3G	TP1221	5E
C1242	6H	CR1542	6C	R1257	5E	R1464	3G	TP1241	7A
C1246	6H	CR1552	7E	R1259	6E	R1466	3G	TP1317	3E
C1251	6G	CR1571	4G	R1311	1E	R1468	3G	TP1347	2D
C1253	6F	CR1577	3B	R1312	2E	R1469	3G	TP1439	2F
C1256	5E	CR1579	4B	R1314	1E	R1472	4G	TP1510	3H
C1257	5E			R1315	1E	R1473	3G		
C1312	2E	P1101	4A	R1321	1E	R1477	3E	U1123	6E
C1316	2D	P1120	3B	R1322	1D	R1478	3E	U1133	5B
C1326	3D	P1145	7A	R1323	3D	R1479	3F	U1146	5C
C1331	3D	P1402	1F	R1326	3C	R1484	3G	U1147	5C
C1334	3E	P1462	1G	R1332	3D	R1485	1G	U1149	4D
C1336	3E	P1587	4G	R1333	3D	R1486	3G	U1151	4B
C1337	3E	Q1152	4B	R1334	3D	R1487	1G	U1175	5E
C1342	2C	Q1346	2C	R1336	3D	R1488	3H	U1176	5F
C1356	2C	Q1551	6D	R1337	3D	R1489	3H	U1177	4F
C1361	3C	Q1571	4G	R1338	3D	R1506	4H	U1179	5G
C1364	3C	Q1576	3C	R1341	3C	R1507	3H	U1180	4D
C1366	4C	Q1577	3B	R1342	2C	R1511	3H	U1206	5F
C1367	3D	Q1594	4G	R1344	1D	R1512	4G	U1223	5E
C1404	1E	R1121	6C	R1345	1D	R1513	4G	U1230	7G
C1437	2F	R1122	6D	R1351	3C	R1516	4G	U1231	6G
C1464	3G	R1123	6D	R1352	3B	R1517	4G	U1236	6F
C1522	7D	R1124	6D	R1353	2B	R1522	7C	U1240	6G
C1543	6C	R1126	6D	R1356	2C	R1523	7D	U1312	2D
C1552	7D	R1127	6C	R1363	3C	R1531	7E	U1313	3D
C1562	7E	R1133	6B	R1364	3C	R1532	7E	U1326	3C
C1563	4H	R1151	3C	R1366	3C	R1533	4B	U1335	3D
C1564	4G	R1152	3C	R1367	3C	R1536	6E	U1342	2C
C1564	4G	R1153	4C	R1368	3C	R1537	6E	U1343	2B
C1571	4H	R1154	4C	R1403	2E	R1538	6E	U1406	2F
C1581	4H	R1161	3C	R1404	1F	R1543	6C	U1420	3F
C1591	5G	R1162	3B	R1406	3E	R1544	7D	U1445	3F
		R1163	4D	R1408	3E	R1547	7C	U1451	4F
		R1164	4B	R1409	1F	R1551	7D	U1452	3F
		R1179	4F	R1412	2E	R1554	3B	U1456	4E
		R1201	5H	R1413	2E	R1556	3B	U1457	4E
		R1202	5G	R1417	3F	R1557	7E	U1466	3G
		R1203	5G	R1418	3F	R1561	4G	U1521	6B
		R1206	5G	R1419	3F	R1562	7E	U1522	7C
		R1207	5G	R1424	1F	R1563	4G	U1547	7B
		R1209	5G	R1425	1G	R1564	4F		
		R1211	5F	R1426	1F	R1566	4F		
		R1212	5F	R1427	1F	R1571	4G		



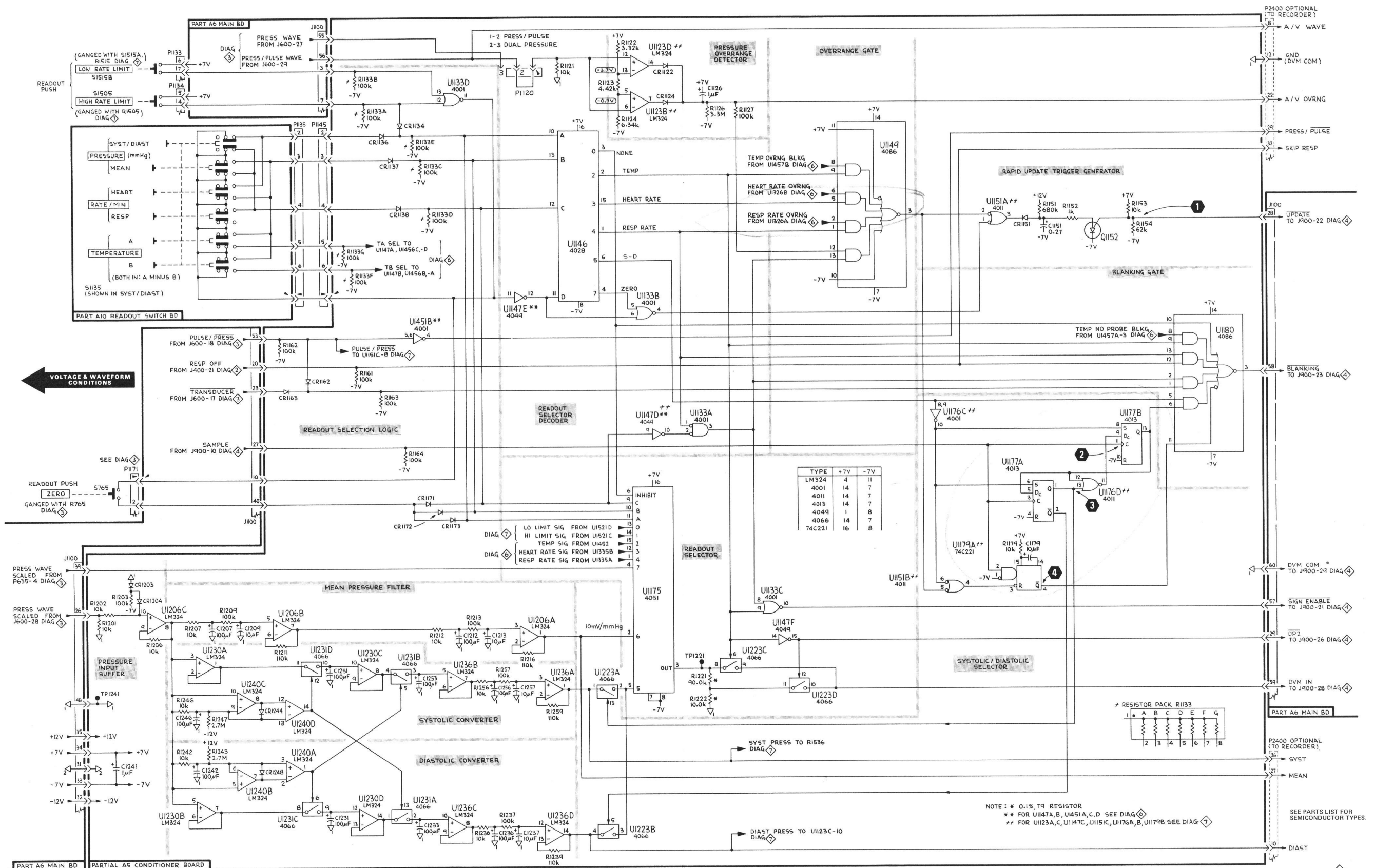
VOLTAGE AND WAVEFORM CONDITIONS

Voltages are design-center values. Voltage are referenced to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms.



RESP OUTPUT
INSTEAD OF A/V



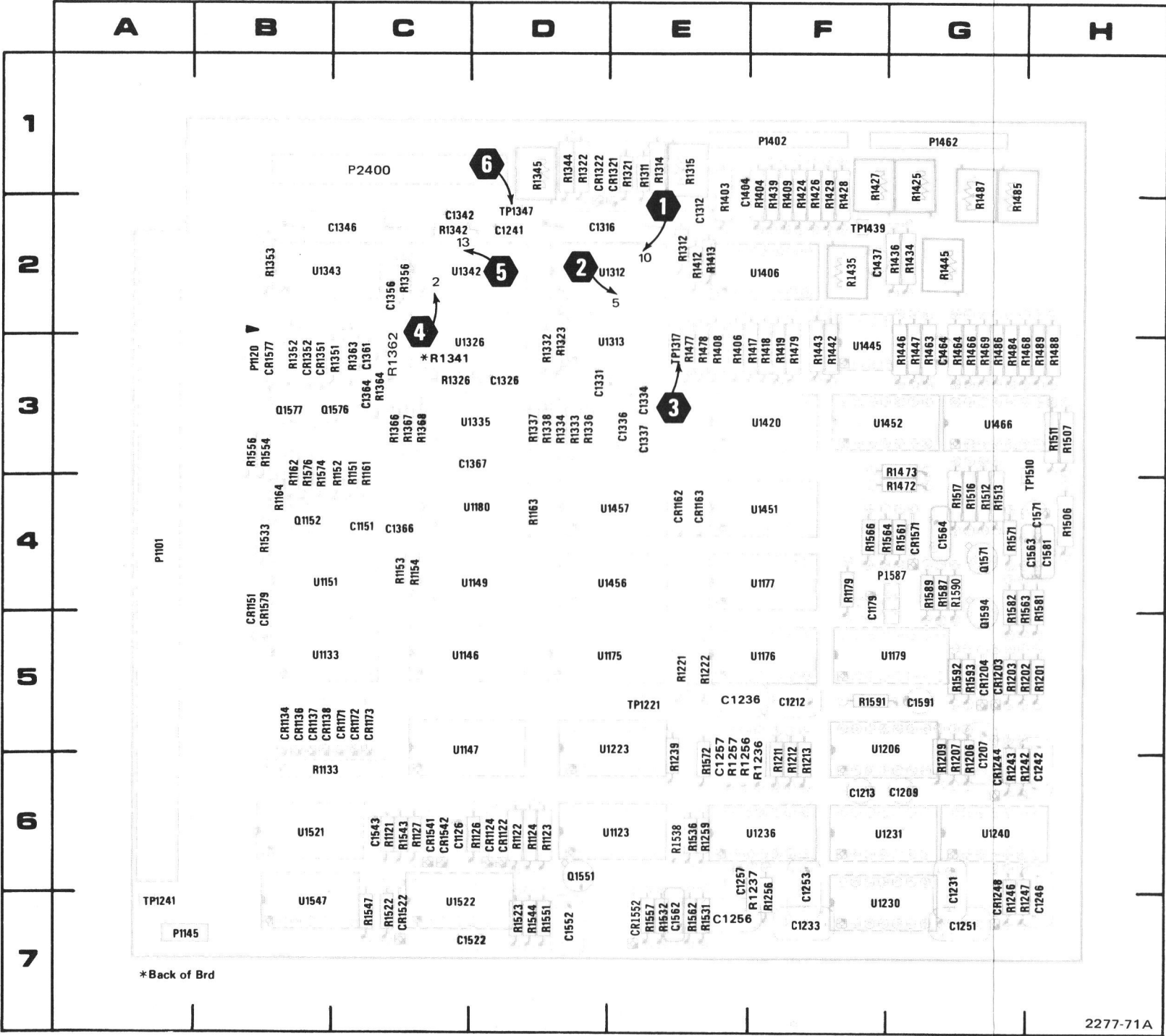
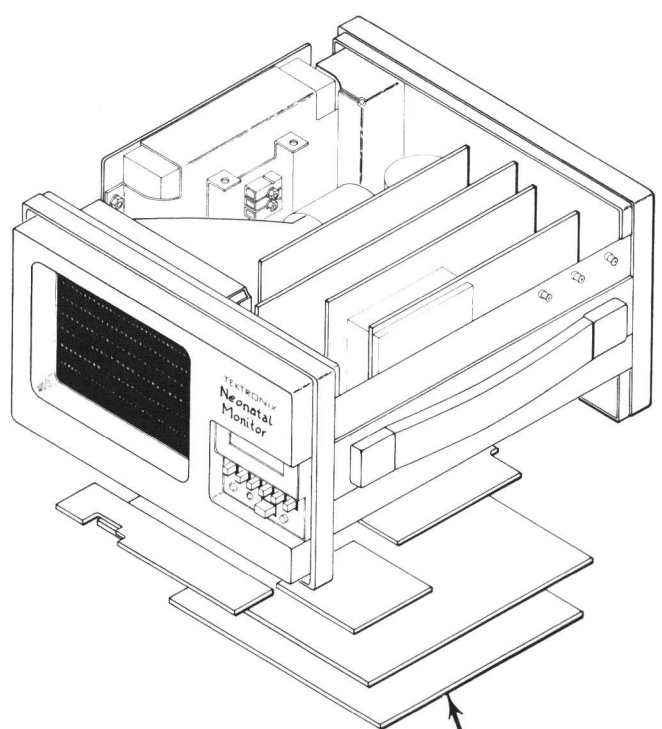


Figure 8-10. A5-Conditioner board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1126	6C	CR1172	5C	R1213	5F	R1428	1F	R1572	5E
C1151	4C	CR1173	5C	R1216	5F	R1429	1F	R1574	3B
C1179	4F	CR1203	5G	R1221	5E	R1434	2G	R1576	3B
C1207	5G	CR1204	5G	R1222	5E	R1435	2F	R1581	4H
C1209	6G	CR1243	6G	R1236	7F	R1436	2G	R1582	4G
C1212	5F	CR1248	6G	R1237	7F	R1439	1F	R1587	4G
C1213	6F	CR1321	1E	R1239	5E	R1442	3F	R1589	4G
C1231	7G	CR1322	1D	R1242	6G	R1443	3F	R1590	4G
C1233	7F	CR1351	3B	R1243	6G	R1445	2G	R1591	5F
C1236	7E	CR1352	3B	R1246	6G	R1446	3G	R1592	5G
		CR1522	7C	R1247	6G	R1447	3G	R1593	5G
C1241	2C	CR1541	6C	R1256	5E	R1463	3G	TP1221	5E
C1242	6H	CR1542	6C	R1257	5E	R1464	3G	TP1241	7A
C1246	6H	CR1552	7E	R1259	6E	R1466	3G	TP1317	3E
C1251	6G	CR1571	4G	R1311	1E	R1468	3G	TP1347	2D
C1253	6F	CR1577	3B	R1312	2E	R1469	3G	TP1439	2F
C1256	5E	CR1579	4B	R1314	1E	R1472	4G	TP1510	3H
C1257	5E			R1315	1E	R1473	3G		
C1312	2E	P1101	4A	R1321	1E	R1477	3E	U1123	6E
C1316	2D	P1120	3B	R1322	1D	R1478	3E	U1133	5B
C1326	3D	P1145	7A	R1323	3D	R1479	3F	U1146	5C
C1331	3D	P1402	1F	R1326	3C	R1484	3G	U1147	5C
C1334	3E	P1462	1G	R1332	3D	R1485	1G	U1149	4D
C1336	3E	P1587	4G	R1333	3D	R1486	3G	U1151	4B
C1337	3E	Q1152	4B	R1334	3D	R1487	1G	U1175	5E
C1342	2C	Q1346	2C	R1336	3D	R1488	3H	U1176	5F
C1356	2C	Q1551	6D	R1337	3D	R1489	3H	U1177	4F
C1361	3C	Q1571	4G	R1338	3D	R1506	4H	U1179	5G
C1364	3C	Q1576	3C	R1341	3C	R1507	3H	U1180	4D
C1366	4C	Q1577	3B	R1342	2C	R1511	3H	U1206	5F
C1367	3D	Q1594	4G	R1344	1D	R1512	4G	U1223	5E
C1404	1E	R1121	6C	R1345	1D	R1513	4G	U1230	7G
C1437	2F	R1122	6D	R1351	3C	R1516	4G	U1231	6G
C1464	3G	R1123	6D	R1352	3B	R1517	4G	U1236	6F
C1522	7D	R1124	6D	R1353	2B	R1522	7C	U1240	6G
C1543	6C	R1126	6D	R1356	2C	R1523	7D	U1312	2D
C1552	7D	R1127	6C	R1362	3C	R1531	7E	U1313	3D
C1562	7E	R1133	6B	R1364	3C	R1532	7E	U1326	3C
C1563	4H	R1151	3C	R1366	3C	R1533	4B	U1335	3D
C1564	4G	R1152	3C	R1367	3C	R1536	6E	U1342	2C
C1564	4G	R1153	4C	R1368	3C	R1537	6E	U1343	2B
C1571	4H	R1154	4C	R1403	2E	R1538	6E	U1406	2F
C1581	4H	R1161	3C	R1404	1F	R1543	6C	U1420	3F
C1591	5G	R1162	3B	R1406	3E	R1544	7D	U1445	3F
		R1163	4D	R1408	3E	R1547	7C	U1451	4F
CR1122	6D	R1164	4B	R1409	1F	R1551	7D	U1452	3F
CR1124	6D	R1179	4F	R1412	2E	R1554	3B	U1456	4E
CR1134	5B	R1201	5H	R1413	2E	R1556	3B	U1457	4E
CR1136	5B	R1202	5G	R1417	3F	R1557	7E	U1466	3G
CR1137	5B	R1203	5G	R1418	3F	R1561	4G	U1521	6B
CR1138	5B	R1206	5G	R1419	3F	R1562	7E	U1522	7C
CR1151	4B	R1207	5G	R1424	1F	R1563	4G	U1547	7B
CR1162	4E	R1209	5G	R1425	1G	R1564	4F		
CR1163	4E	R1211	5F	R1426	1F	R1566	4F		
CR1171	5C	R1212	5F	R1427	1F	R1571	4G		

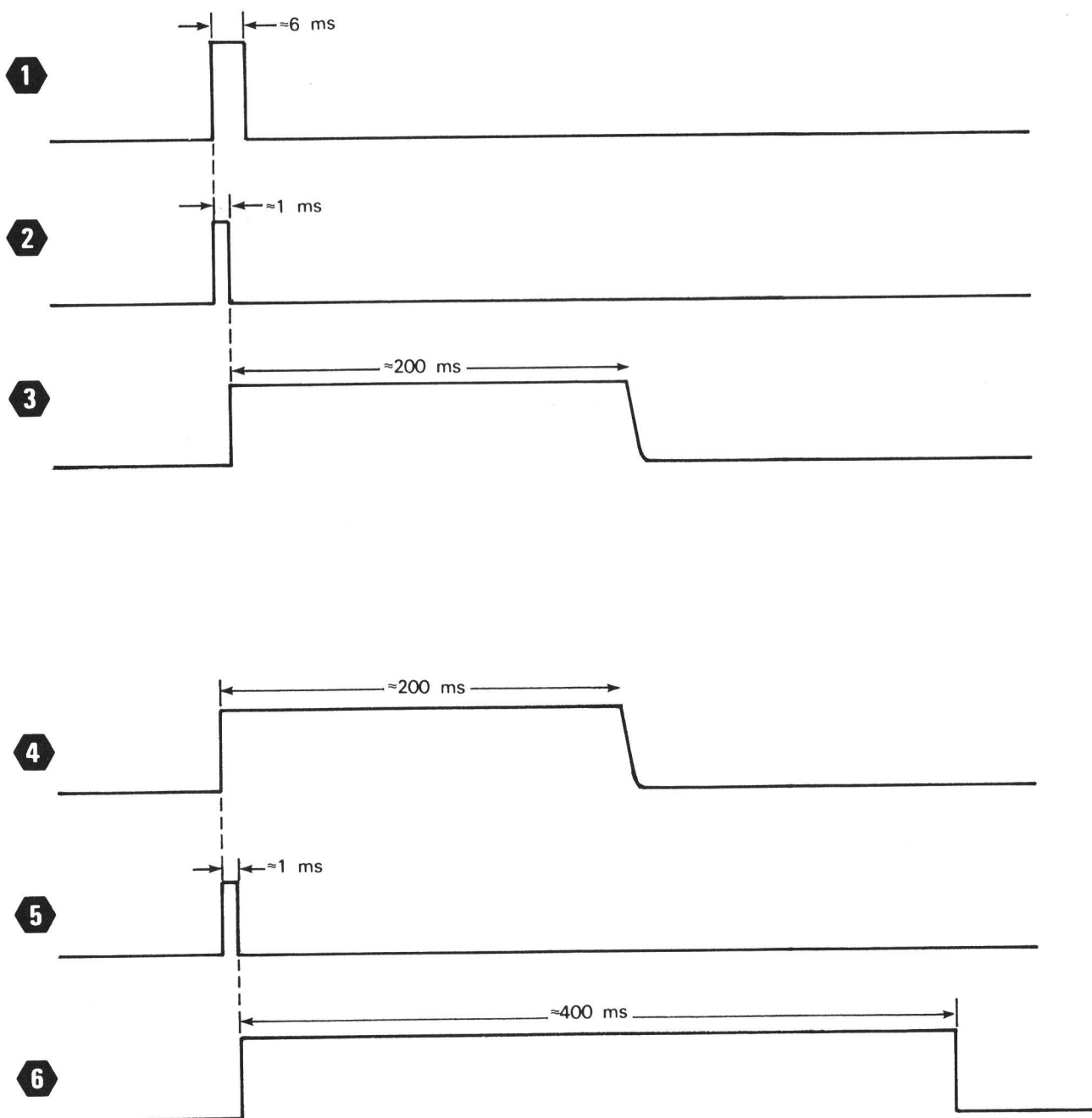


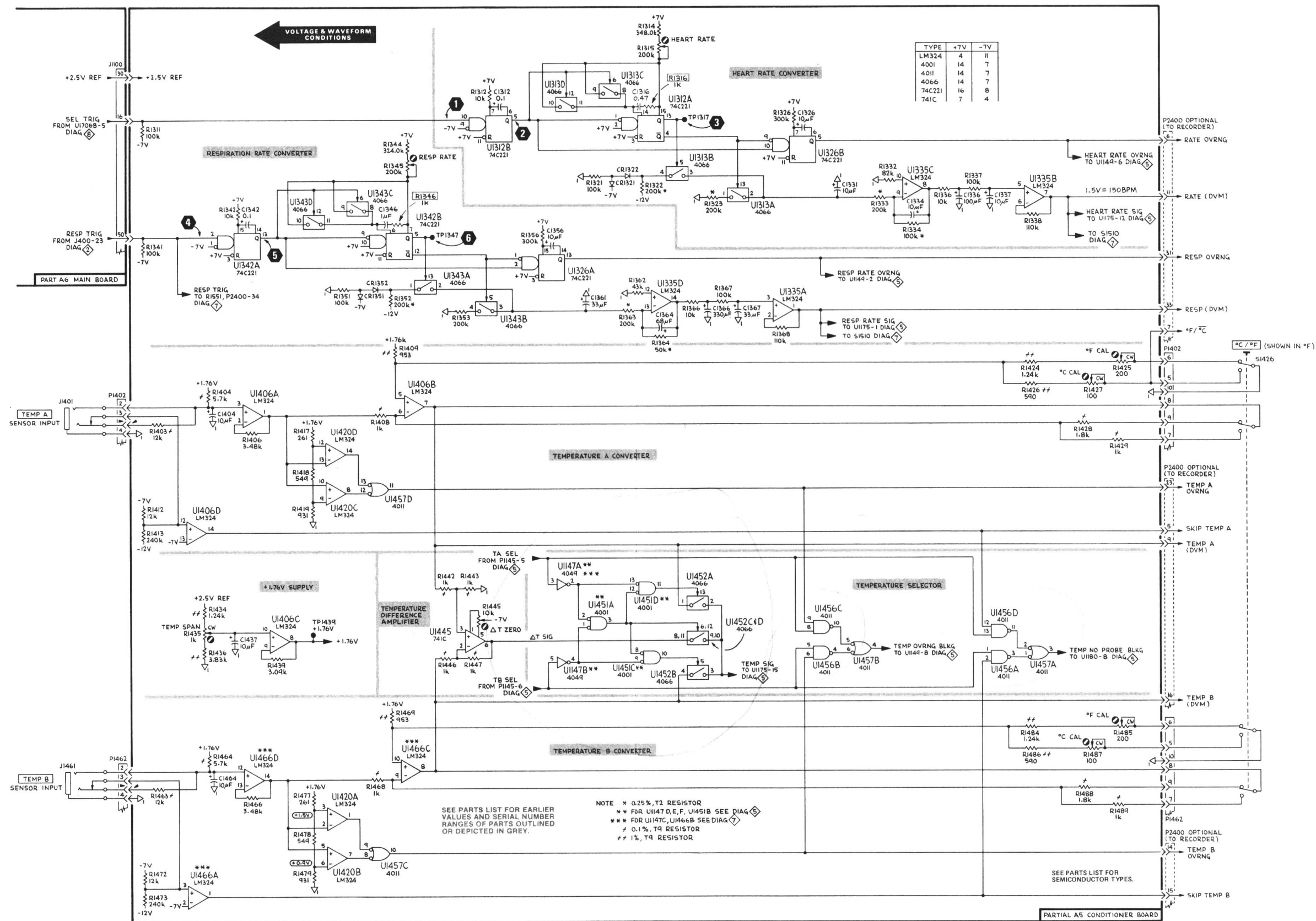
A5—CONDITIONER

VOLTAGE, AND WAVEFORM CONDITIONS

Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms. Heart-rate and respiration-rate signals must be present.





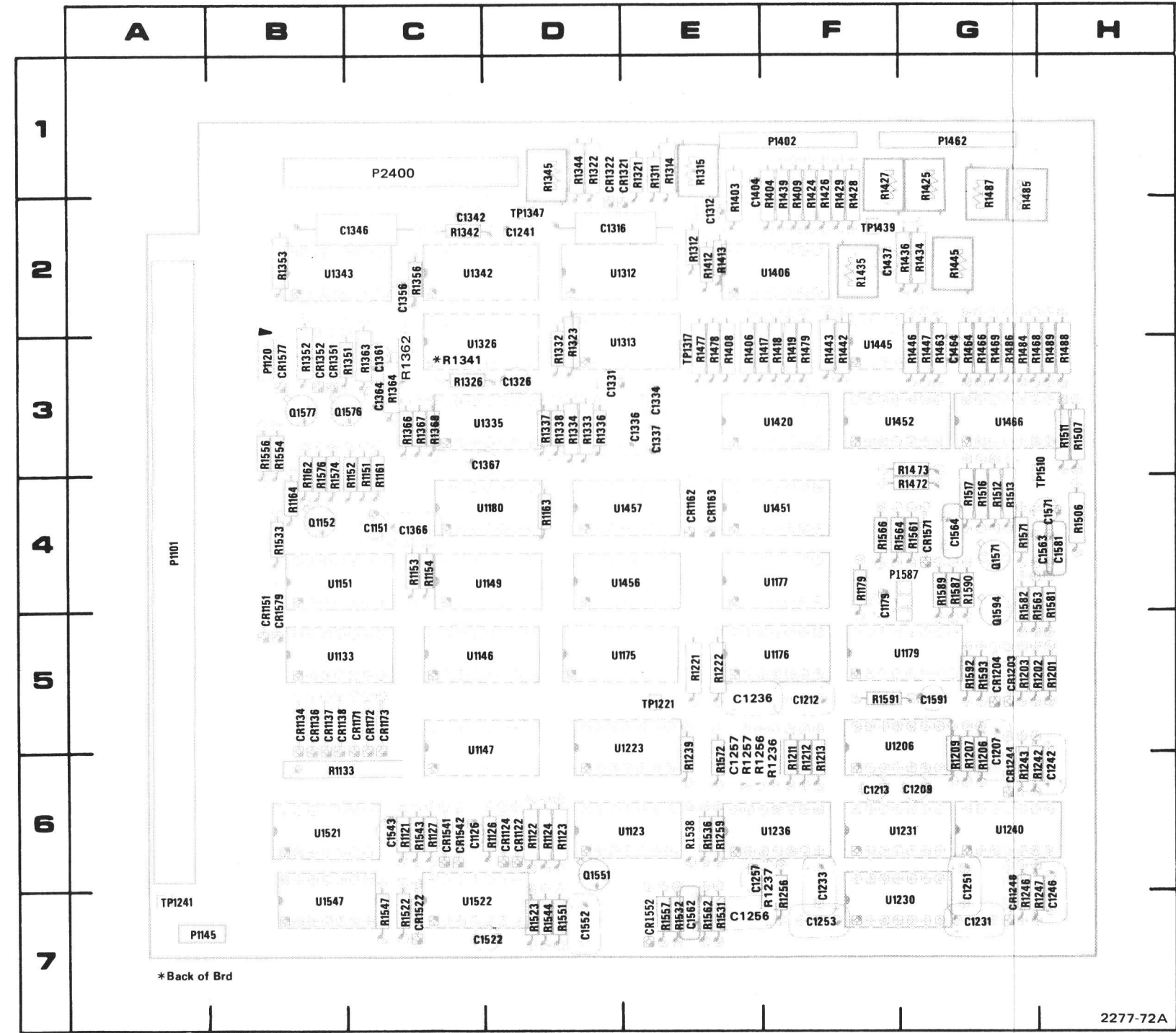
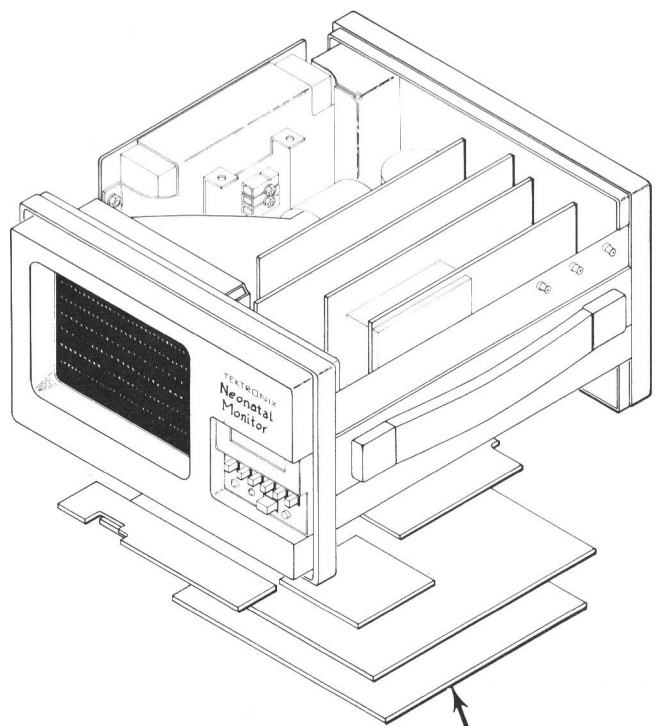


Figure 8-11. A5-Conditioner board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1126	6C	CR1172	5C	R1213	5F	R1428	1F	R1572	5E
C1151	4C	CR1173	5C	R1216	5F	R1429	1F	R1574	3B
C1179	4F	CR1203	5G	R1221	5E	R1434	2G	R1576	3B
C1207	5G	CR1204	5G	R1222	5E	R1436	2F	R1581	4H
C1209	6G	CR1243	6G	R1236	7F	R1436	2G	R1582	4G
C1212	5F	CR1248	6G	R1237	7F	R1439	1F	R1587	4G
C1213	6F	CR1321	1E	R1239	5E	R1442	3F	R1589	4G
C1231	7G	CR1322	1D	R1242	6G	R1443	3F	R1590	4G
C1233	7F	CR1351	3B	R1243	6G	R1445	2G	R1591	5F
C1236	7E	CR1352	3B	R1246	6G	R1446	3G	R1592	5G
		CR1522	7C	R1247	6G	R1447	3G	R1593	5G
C1241	2C	CR1541	6C	R1256	5E	R1463	3G	TP1221	5E
C1242	6H	CR1542	6C	R1257	5E	R1464	3G	TP1241	7A
C1246	6H	CR1552	7E	R1259	6E	R1466	3G	TP1317	3E
C1251	6G	CR1571	4G	R1311	1E	R1468	3G	TP1347	2D
C1253	6F	CR1577	3B	R1312	2E	R1469	3G	TP1439	2F
C1256	5E	CR1579	4B	R1314	1E	R1472	4G	TP1510	3H
C1257	5E			R1315	1E	R1473	3G		
C1312	2E	P1101	4A	R1321	1E	R1477	3E	U1123	6E
C1316	2D	P1120	3B	R1322	1D	R1478	3E	U1133	5B
C1326	3D	P1145	7A	R1323	3D	R1479	3F	U1146	5C
C1331	3D	P1402	1F	R1326	3C	R1484	3G	U1147	5C
C1334	3E	P1462	1G	R1332	3D	R1485	1G	U1149	4D
C1336	3E	P1587	4G	R1333	3D	R1486	3G	U1151	4B
C1337	3E	Q1152	4B	R1334	3D	R1487	1G	U1175	5E
C1342	2C	Q1346	2C	R1336	3D	R1488	3H	U1176	5F
C1356	2C	Q1551	6D	R1337	3D	R1489	3H	U1177	4F
C1361	3C	Q1571	4G	R1338	3D	R1506	4H	U1179	5G
C1364	3C	Q1576	3C	R1341	3C	R1507	3H	U1180	4D
C1366	4C	Q1577	3B	R1342	2C	R1511	3H	U1206	5F
C1367	3D	Q1594	4G	R1344	1D	R1512	4G	U1223	5E
C1404	1E	R1121	6C	R1345	1D	R1513	4G	U1230	7G
C1437	2F	R1122	6D	R1351	3C	R1516	4G	U1231	6G
C1464	3G	R1123	6D	R1352	3B	R1517	4G	U1236	6F
C1522	7D	R1124	6D	R1353	2B	R1522	7C	U1240	6G
C1543	6C	R1126	6D	R1356	2C	R1523	7D	U1312	2D
C1552	7D	R1127	6C	R1362	3C	R1531	7E	U1313	3D
C1562	7E	R1133	6B	R1363	3C	R1532	7E	U1326	3C
C1563	4H	R1151	3C	R1366	3C	R1533	4B	U1335	3D
C1564	4G	R1152	3C	R1367	3C	R1536	6E	U1342	2C
C1564	4G	R1153	4C	R1368	3C	R1537	6E	U1343	2B
C1571	4H	R1154	4C	R1403	2E	R1538	6E	U1406	2F
C1581	4H	R1161	3C	R1404	1F	R1543	6C	U1420	3F
C1591	5G	R1162	3B	R1406	3E	R1544	7D	U1445	3F
		R1163	4D	R1408	3E	R1547	7C	U1451	4F
		R1164	4B	R1409	1F	R1551	7D	U1452	3F
CR1122	6D	R1179	4F	R1412	2E	R1554	3B	U1456	4E
CR1124	6D	R1201	5H	R1413	2E	R1556	3B	U1457	4E
CR1134	5B	R1202	5G	R1417	3F	R1557	7E	U1466	3G
CR1136	5B	R1203	5G	R1418	3F	R1561	4G	U1521	6B
CR1137	5B	R1206	5G	R1419	3F	R1562	7E	U1522	7C
CR1138	5B	R1207	5G	R1424	1F	R1563	4G	U1547	7B
CR1151	4B	R1209	5G	R1425	1G	R1564	4F		
CR1162	4E	R1211	5F	R1426	1F	R1566	4F		
CR1163	4E	R1212	5F	R1427	1F	R1571	4G		
CR1171	5C								



A5—CONDITIONER

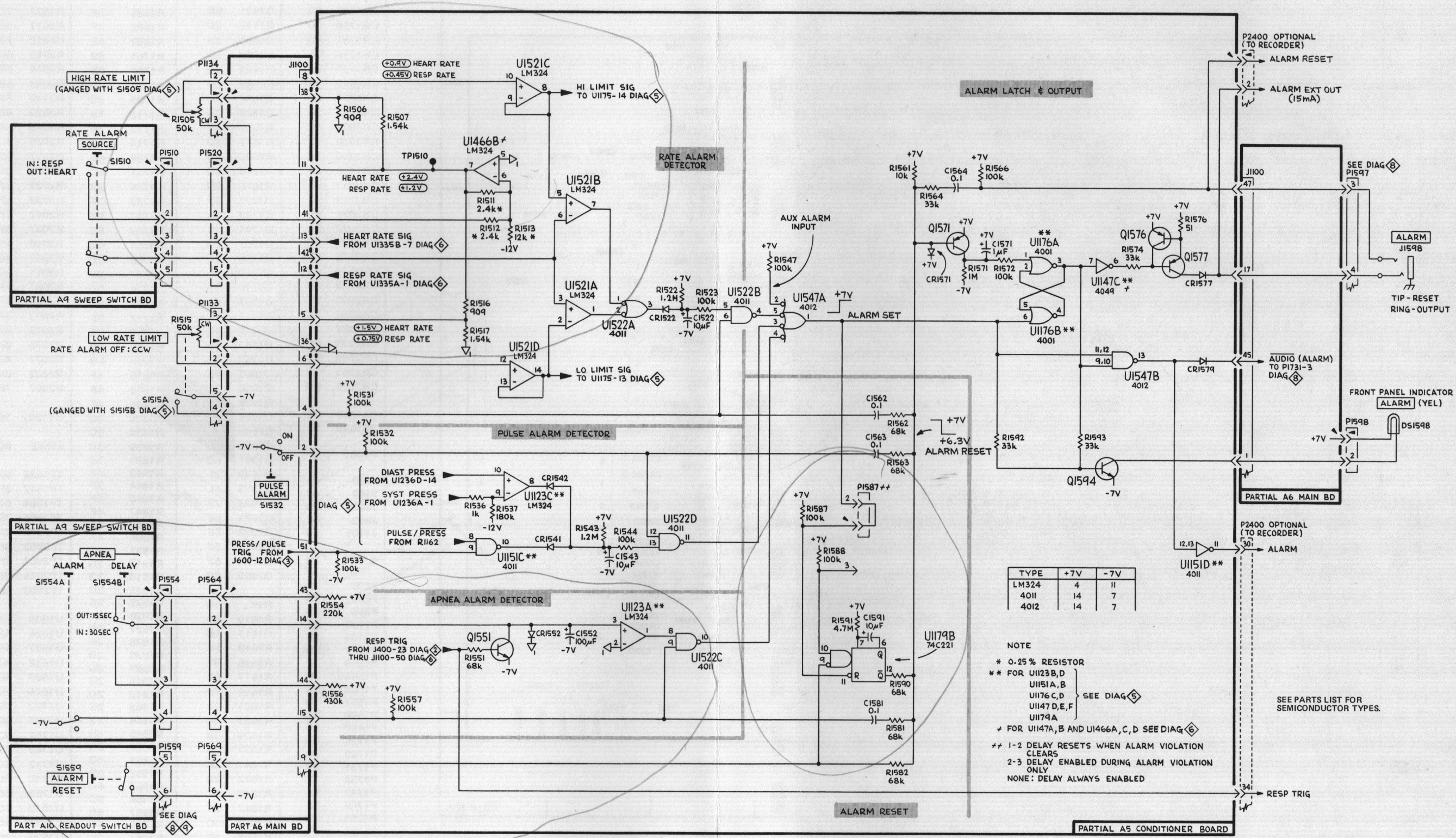
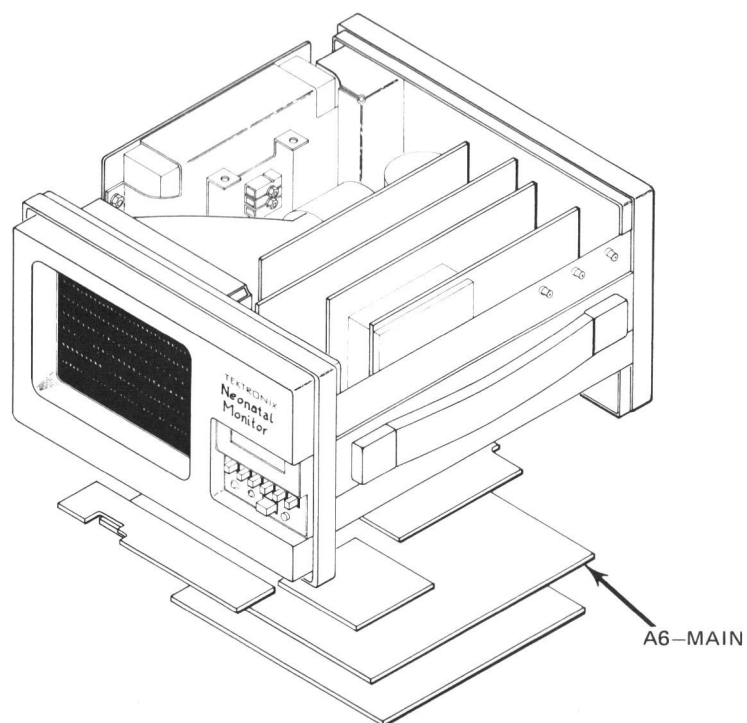




Figure 8-12. A6-Main board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1619	6B	C1684	3E	C1777	5G	C1939	2G	C2016	5E	C2077	7H	C2089	6I	CR1677	2C	CR1725	6B
C1636	3B	C1706	3D	C1794	5F	C1959	6G	C2041	5E	C2081	7H	C2093	7I	CR1683	3E	CR1726	5C
C1637	2B	C1732	1C	C1797	4G	C1961	6G	C2053	6G	C2082	7I	C2097	7H	CR1714	1B	CR1727	5C
C1641	2B	C1734	5E	C1837	3G	C1969	5H	C2064	6G	C2083	7I			CR1717	6B	CR1729	6B
C1648	3C	C1751	6D	C1911	2F	C1990	7G	C2073	6G	C2087	6H	CR1649	3C	CR1718	6B	CR1746	6D
C1656	3D	C1771	3D	C1916	2H	C1994	7F			C2088	6I	CR1667	1E	CR1719	6B	CR1747	6D

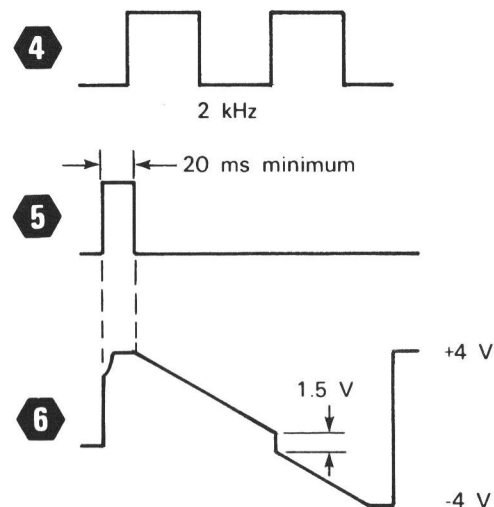
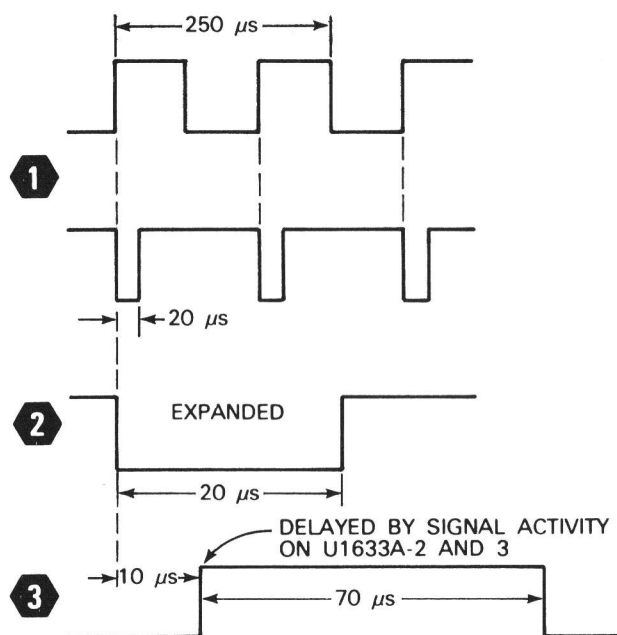
CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
CR1748	5D	Q1621	6B	R1685	3F	R1997	7F
CR1749	6D	Q1642	2D	R1686	3F	R2011	6E
CR1751	5D	Q1656	2D	R1687	3E	R2012	7E
CR1776	5G	Q1657	2D	R1701	2B	R2013	6E
CR1793	5G	Q1662	2D	R1702	2B	R2014	5E
CR1812	4F	Q1663	2D	R1704	4D	R2018	6E
CR1837	3G	Q1664	2E	R1706	3D	R2019	6E
CR1864	3E	Q1666	2E	R1712	1B	R2023	6E
CR1916	2H	Q1667	2E	R1713	1B	R2026	6E
CR1926	3H	Q1672	2D	R1714	1B	R2026	7G
CR1945	3H	Q1673	2D	R1725	6B	R2027	6E
CR1996	7F	Q1674	2D	R1727	5C	R2031	6F
CR2041	5F	Q1676	2D	R1729	6B	R2032	5F
CR2063	6F	Q1677	2E	R1732	5E	R2033	6F
CR2071	6H	Q1713	1A	R1734	5E	R2042	5F
CR2072	6H	Q1714	1B	R1742	5C	R2043	5F
CR2075	6H	Q1751	2A	R1751	6D	R2046	6G
CR2076	6H	Q1758	4F	R1758	5E	R2047	6G
CR2079	5H	Q1759	4F	R1771	2D	R2051	6G
CR2080	6H	Q1776	5G	R1774	5G	R2061	6F
CR2085	5H	Q1793	4F	R1776	5G	R2064	6F
CR2086	5H	Q1812	4F	R1777	5F	R2062	6F
CR2087	7F	Q1842	4E	R1777	5G	R2073	6H
CR2091	6H	Q1843	4E	R1792	5G	R2075	6H
CR2092	6H	Q1852	4E	R1793	5G	R2077	4G
CR2095	7H	Q1853	4E	R1812	4F	R2092	6H
CR2096	6H	Q1936	2H	R1813	4F	R2097	7H
		Q1939	2H	R1814	4F		
DS1648	3C	Q1944	2H	R1820	4G	RT1922	3G
DS1649	3C	Q1945	3I	R1834	3G		
		Q1966	5G	R1835	3G	S1532	8D
F1981	2I	Q1967	5G	R1836	3G		
		Q1972	3I	R1842	4E	TP1623	5C
J100	4A	Q1973	4I	R1844	3F	TP1972	6I
J400	4C	Q1993	7F	R1845	3F	TP1984	6G
J600	4D	Q2021	6E	R1847	4F	TP1994	7G
J900	4E	Q2029	6E	R1852	4E	TP2077	8H
J1100	4A	Q2049	5F	R1856	4F	TP2083	8H
		Q2051	5F	R1857	4F	TP2084	8H
K1913	2H	Q2053	5G	R1913	2G	TP2089	8I
				R1918	3G	TP2093	8I
P205	7B			R1919	2G		
P635	7D	R16	1D	R1923	3G		
P956	8B	R1610	5B	R1926	3H	U1623	5B
P1133	8E	R1611	5B	R1927	3H	U1626	4B
P1134	7F	R1613	5B	R1928	2H	U1627	4B
P1171	8D	R1616	5B	R1936	2G	U1632	4C
P1520	7E	R1617	6B	R1937	2G	U1633	3B
P1564	7F	R1619	5B	R1939	2G	U1649	2C
P1569	8G	R1621	6B	R1942	2G	U1649	2C
P1597	1D	R1621	6B	R1943	2G	U1702	3B
P1598	8A	R1631	4C	R1944	2G	U1706	3D
P1690	3E	R1636	3B	R1945	4H	U1707	6C
P1725	7B	R1637	2B	R1959	5G	U1709	5C
P1729	7C	R1641	2B	R1961	6G	U1712	4D
P1731	2A	R1642	2B	R1962	6G	U1745	5D
P1733	7G	R1642	2B	R1963	6G	U1758	5F
P1742	8F	R1646	3C	R1966	6G	U1810	4G
P1748	1E	R1647	3C	R1967	6G	U1841	4G
P1759	7H	R1652	1C	R1969	5G	U1926	2G
P1782	7F	R1653	1C	R1981	2I	U1984	7E
P1910	1G	R1658	1C	R1984	7F	U1984	7E
P1956	7G	R1659	1C	R1987	7F	U1987	6F
P1977	7C	R1662	1E	R1989	7G	U2033	6F
P1982	2I	R1667	1C	R1990	6F		
				R1991	7G		
Q1613	6B	R1672	2C	R1993	7F	VR1961	6G
Q1617	6B	R1677	1C	R1996	6F		
		R1684	3E				

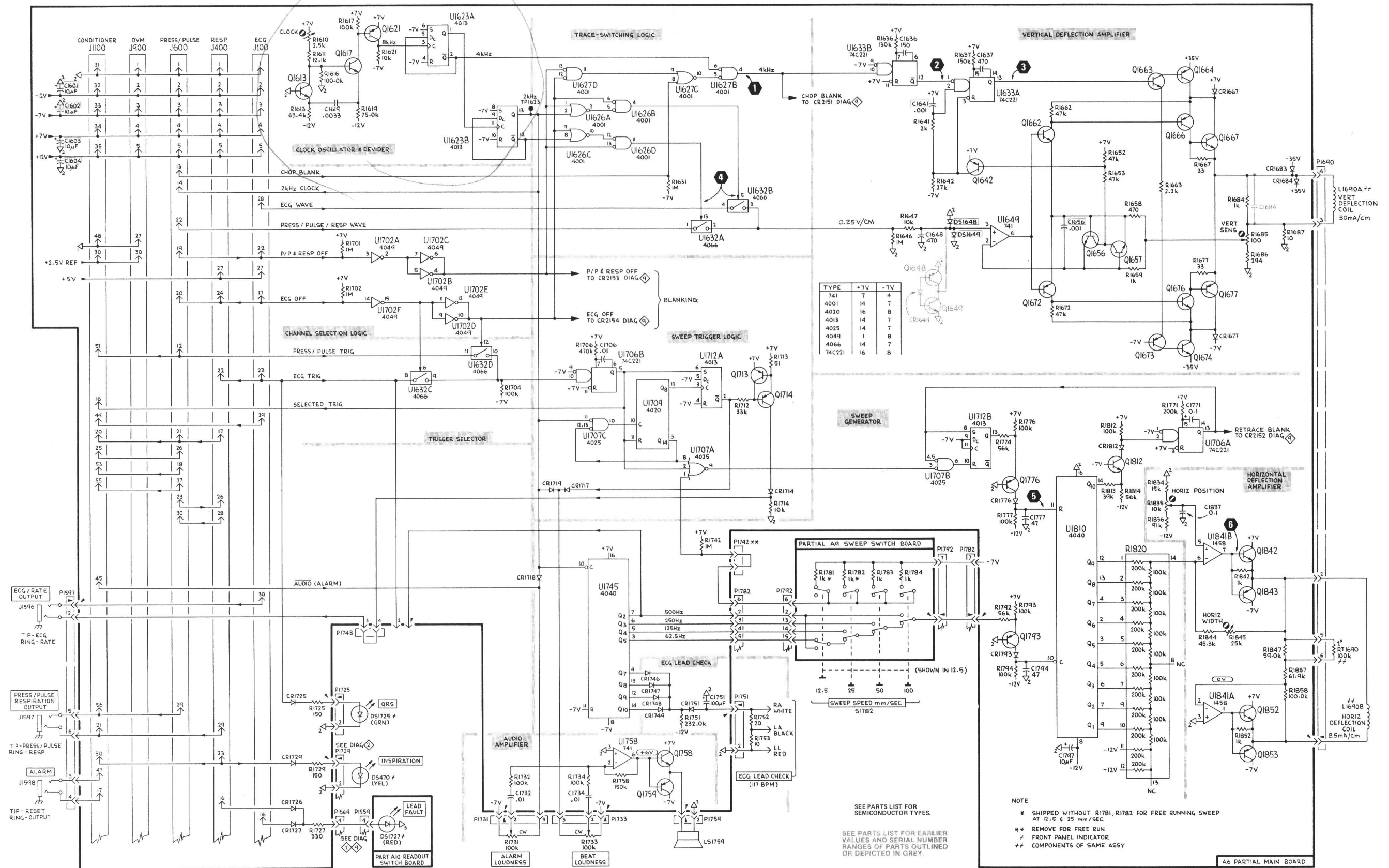


CURRENT, VOLTAGE, AND WAVEFORM CONDITIONS

Currents or voltages are design-center values. Voltages are referenced to chassis ground.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms. Waveforms 1, 2, and 3 are present only for multi-trace displays. Waveform 4 present only when Press/Pulse/Resp and ECG both displayed. Waveforms 5 and 6 are for free-running 100 mm/SEC sweep. Waveform 5 pulse width changes when sweep is not free-running.





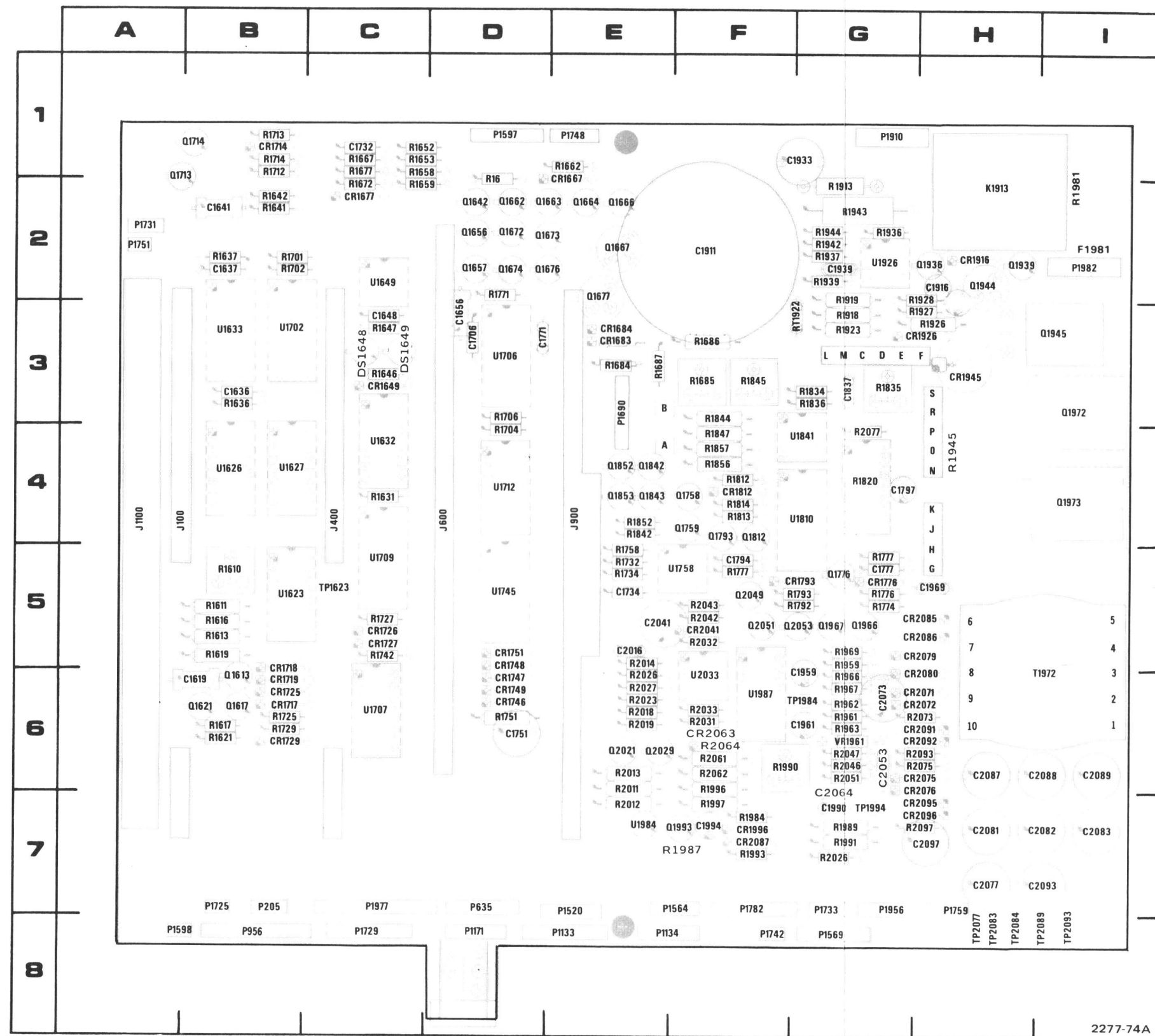
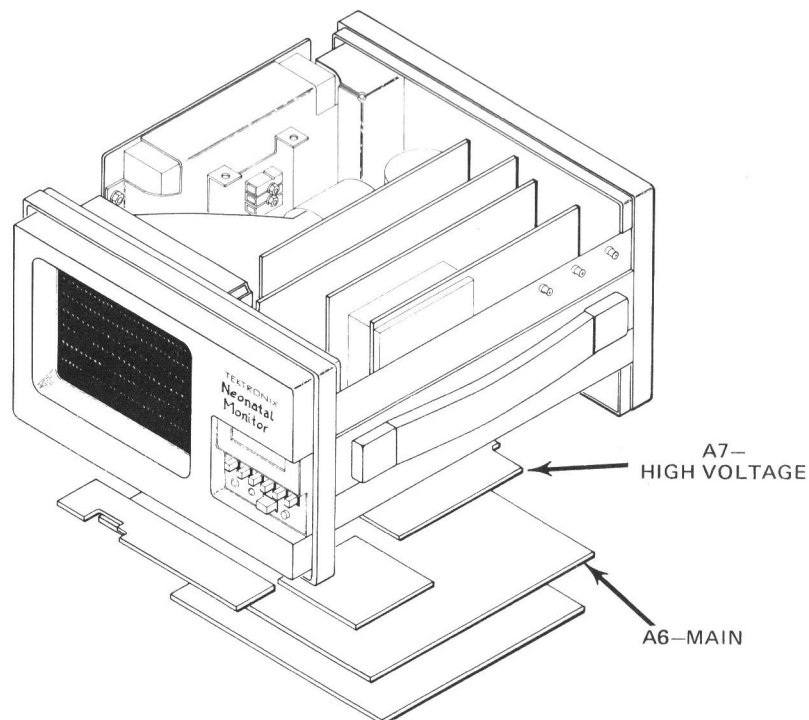


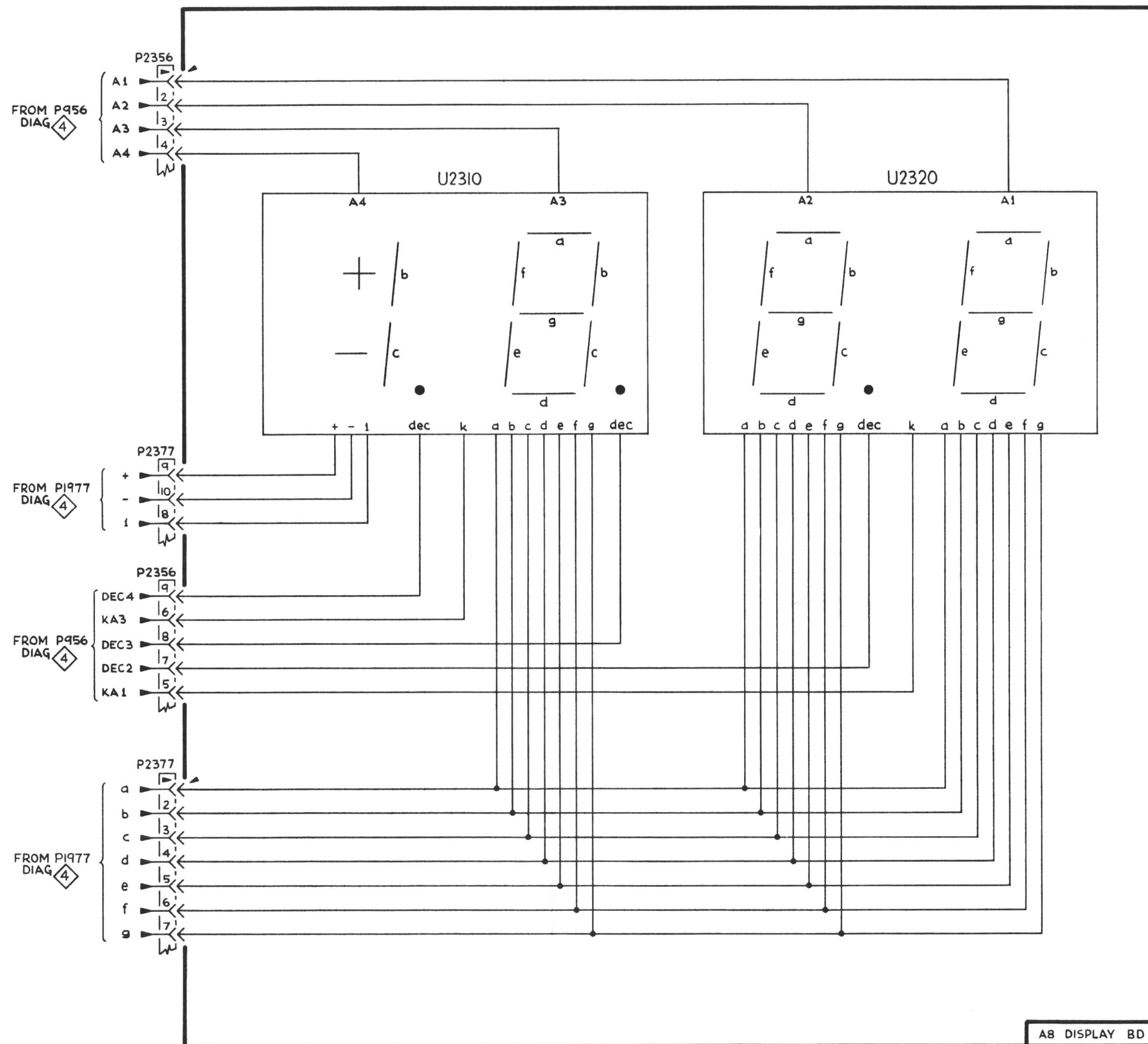
Figure 8-13. A6-Main board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C1619	6B	C1684	3E	C1777	5G	C1939	2G	C2016	5E	C2077	7H	C2089	6I	CR1677	2C
C1636	3B	C1706	3D	C1794	5F	C1959	6G	C2041	5E	C2081	7H	C2093	7I	CR1683	3E
C1637	2B	C1732	1C	C1797	4G	C1961	6G	C2053	6G	C2082	7I	C2097	7H	CR1714	1B
C1641	2B	C1734	5E	C1911	2F	C1969	5H	C2064	6G	C2083	7I			CR1717	6B
C1648	3C	C1751	6D	C1916	2H	C1990	7G	C2064	6G	C2087	6H			CR1718	6B
C1656	3D	C1771	3D			C1994	7F	C2073	6G	C2088	6I			CR1719	6B

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
CR1748	5D	Q1621	6B	R1685	3F	R1997	7F
CR1749	6D	Q1642	2D	R1686	3F	R2011	6E
CR1751	5D	Q1656	2D	R1687	3E	R2012	7E
CR1776	5G	Q1657	2D	R1701	2B	R2013	6E
CR1793	5G	Q1662	2D	R1702	2B	R2014	5E
CR1812	4F	Q1663	2D	R1704	4D	R2018	6E
CR1837	3G	Q1664	2E	R1706	3D	R2019	6E
CR1864	3E	Q1666	2E	R1712	1B	R2023	6E
CR1916	2H	Q1667	2E	R1713	1B	R2026	6E
CR1926	3H	Q1672	2D	R1714	1B	R2026	7G
CR1945	3H	Q1673	2D	R1725	6B	R2027	6E
CR1996	7F	Q1674	2D	R1727	5C	R2031	6F
CR2041	5F	Q1676	2D	R1729	6B	R2032	5F
CR2063	6F	Q1677	2E	R1732	5E	R2033	6F
CR2071	6H	Q1713	1A	R1734	5E	R2042	5F
CR2072	6H	Q1714	1B	R1742	5C	R2043	5F
CR2075	6H	Q1751	2A	R1751	6D	R2046	6G
CR2076	6H	Q1758	4F	R1758	5E	R2047	6G
CR2079	5H	Q1759	4F	R1771	2D	R2051	6G
CR2080	6H	Q1776	5G	R1774	5G	R2061	6F
CR2085	5H	Q1793	4F	R1776	5G	R2064	6F
CR2086	5H	Q1812	4F	R1777	5F	R2062	6F
CR2087	7F	Q1842	4E	R1777	5G	R2073	6H
CR2091	6H	Q1843	4E	R1792	5G	R2075	6H
CR2092	6H	Q1852	4E	R1793	5G	R2077	4G
CR2095	7H	Q1853	4E	R1812	4F	R2092	6H
CR2096	6H	Q1936	2H	R1813	4F	R2097	7H
		Q1939	2H	R1814	4F		
DS1648	3C	Q1944	2H	R1820	4G	RT1922	3G
DS1649	3C	Q1945	3I	R1834	3G		
		Q1966	5G	R1835	3G	S1532	8D
F1981	2I	Q1967	5G	R1836	3G		
		Q1972	3I	R1842	4E	TP1623	5C
J100	4A	Q1973	4I	R1844	3F	TP1972	6I
J400	4C	Q1993	7F	R1845	3F	TP1984	6G
J600	4D	Q2021	6E	R1847	4F	TP1994	7G
J900	4E	Q2029	6E	R1852	4E	TP2077	8H
J1100	4A	Q2049	5F	R1856	4F	TP2083	8H
		Q2051	5F	R1857	4F	TP2084	8H
K1913	2H	Q2053	5G	R1913	2G	TP2089	8I
				R1918	3G	TP2093	8I
P205	7B			R1919	2G		
P635	7D	R16	1D	R1923	3G		
P956	8B	R1610	5B	R1926	3H	U1623	5B
P1133	8E	R1611	5B	R1927	3H	U1626	4B
P1134	7F	R1613	5B	R1928	2H	U1627	4B
P1171	8D	R1616	5B	R1936	2G	U1632	4C
P1520	7E	R1617	6B	R1937	2G	U1633	3B
P1564	7F	R1619	5B	R1939	2G	U1649	2C
P1569	8G	R1621	6B	R1942	2G	U1702	3B
P1597	1D	R1631	4C	R1943	2G	U1706	3D
P1598	8A	R1636	3B	R1944	2G	U1707	6C
P1690	3E	R1637	2B	R1945	4H	U1709	5C
P1725	7B	R1641	2B	R1959	5G	U1712	4D
P1729	7C	R1642	2B	R1961	6G	U1745	5D
P1731	2A	R1646	3C	R1962	6G	U1758	5F
P1733	7G	R1647	3C	R1963	6G	U1810	4G
P1742	8F	R1652	1C	R1966	6G	U1841	4G
P1748	1E	R1653	1C	R1967	6G	U1926	2G
P1759	7H	R1658	1C	R1969	5G	U1984	7E
P1782	7F	R1659	1C	R1981	2I	U1987	6F
P1910	1G	R1662	1E	R1984	7F	U2033	6F
P1956	7G	R1667	1C	R1987	7F		
P1977	7C	R1672	2C	R1989	7G		
P1982	2I	R1677	1C	R1990	6F		
		R1684	3E	R1991	7G		
				R1993	7F		
				R1996	6F		

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C2121	2D	CR2122	2D	CR2154	2B	R2133	1D
C2122	2D	CR2123	2D	CR2156	2B	R2134	1E
C2123	1D	CR2124	2D	CR2161	3C	R2137	3D
C2124	2D	CR2125	2D	CR2163	3B	R2140	1B
C2125	2D	CR2126	2D			R2142	2B
C2126	3D	CR2143	2A	Q2142	1B	R2143	2A
C2146	2B	CR2146	2B	Q2146	1A	R2154	2B
C2161	3C	CR2151	2B			R2156	2B
C2163	3B	CR2152	2B	R2121	2C	R2161	3C
		CR2153	2B	R2131	1D	R2163	3B
CR2121	2C			R2132	1D		





A8 DISPLAY BD

ECG BOARD
J100 PIN ASSIGNMENTS

PIN	DESCRIPTION	TO/FROM
1	Ground #2	
2	-12 V	
3	-7 V	
4	+7 V	
5	+12 V	
6	NC	
7	NC	
8	NC	
9	NC	
10	NC	
11	NC	
12	NC	
13	NC	
14	NC	
15	NC	
16	Lead Fault	CR1627
17	ECG Off	J600-20, U1702F-14, J400-24
18	ECG SIZE R210 (CCW)	P210-1
19	ECG SIZE R210 (slider)	P210-2
20	ECG SIZE R210 (CW)	P210-3
21	QRS Disable	Not used
22	Press/Pulse & Resp Display Off	R222, U1702A, J600-19
23	ECG Trig	J400-22 Not used in Standard 413
24	Spare	
25	Spare	
26	Spare	
27	+5 V	
28	ECG Wave (0.25 V/Cm)	U1632B-4
29	-ECG Wave	P1100-49, P2400-24, U215C-8
30	ECG Wave (X1000)	P1597-1

RESPIRATION BOARD
J400 PIN ASSIGNMENTS

PIN	DESCRIPTION	TO/FROM
1	Ground #2	
2	-12 V	
3	-7 V	
4	+7 V	
5	+12 V	
6	NC	
7	NC	
8	NC	
9	NC	
10	NC	
11	NC	
12	NC	
13	NC	
14	NC	
15	NC	
16	Lead Fault	CR1726
17	Resp Display Off	J600-21
18	Resp SIZE R470 (CCW)	P470-3
19	Resp SIZE R470 (slider)	P470-4
20	Resp SIZE R470 (CW)	P470-5
21	Resp Off	J1100-32
22	ECG Trig	J100-23 Not used in Standard 413
23	Resp Trig	J1100-50, CR1729
24	ECG Off	J100-17, J600-20, U1702F-14
25	Pulse/Pressure	J1100-53, J600-18, U711C-6
26	Press/Pulse Display Off	J600-23
27	+5 V	
28	Resp Wave (0.25 V/Cm)	J600-30
29	Resp Wave (0.5 V/Cm)	J1100-21, P1597-6, U439A-1
30	Resp Wave (1 V/ohm)	Not used

PRESSURE/PULSE BOARD
J600 PIN ASSIGNMENTS

PIN	DESCRIPTION	TO/FROM
1	Ground #2	
2	-12 V	
3	-7 V	
4	+7 V	
5	+12 V	
6	Pulse SIZE R635 (CCW)	P635-3
7	Pulse SIZE R635 (slider)	P635-2
8	Pulse SIZE R635 (CW)	P635-1
9	Pressure ZERO R765 (CCW)	P1171-5
10	Pressure ZERO R765 (slider)	P1171-4
11	Pressure ZERO R765 (W)	P1171-3
12	Press/Pulse Trigger	J1100-51, U1632C-11
13	Chop Blank	U1627C-8
14	Chop Clock (2 kHz)	U1623B-13
15	+7 V	J1100-52, P2400-4
16	Transducer	J1100-22, U739B-4, P2400-21
17	Transducer	J1100-23, CR1163
18	Pulse/Pressure	J1100-53, J400-25, U711C-6
19	Press/Pulse & Resp Display Off	J100-22, U1702A, R222
20	ECG Off	J100-17, J400-24, U1702F-14
21	Resp Display Off	J400-17
22	Press/Pulse/Resp Wave	U1632A-1
23	Press/Pulse Display Off	J400-26
24	NC	
25	Press Wave Scaled	J1100-54, P635-5, U872C-8, P2400-3
26	Pulse Wave	J1100-25
27	Press Wave	J1100-55, U872D-14
28	Press Wave Scaled	J1100-26, R1202
29	Press Wave	J1100-56, S605B
30	Resp Wave (0.25 V/Cm)	J400-28

**DVM BOARD
J900 PIN ASSIGNMENTS**

PIN	DESCRIPTION	TO/FROM
1	Ground #1	
2	-12 V	
3	-7 V	
4	+7 V	
5	+12 V	
6	26 V p-p Approx 30 kHz	T1010
7	26 V p-p Approx 30 kHz	T1010
8	Spare	
9	Spare	
10	Sample (DVM)	Q1043, U1177B-11
11	- sign	P977-10, Q1061
12	+ sign	P977-9, Q1062
13	1 (half digit)	P977-8, Q982
14	g	P977-7, U975-14
15	f	P977-6, U975-15
16	e	P977-5, U975-9
17	d	P977-4, U975-10
18	c	P977-3, U975-11
19	b	P977-2, U975-12
20	a	P977-1, U975-13
21	Sign Enable	J1100-57, U1133C-10
22	Update (DVM)	J1100-28
23	Blanking	J1100-58, U1180-3
24	DP4	
25	DP3	
26	DP2	
27	Ground #1	
28	DVM In	J1100-59, U1223d-10
29	DVM Com	Gnd #1, J1100-60
30	+2.5 V Reference	
31	NC	
32	NC	
33	NC	
34	NC	
35	NC	
36	NC	
37	NC	
38	NC	
39	NC	
40	NC	
41	KA1	P956-5
42	KA3	P956-6
43	DEC2	P956-7
44	DEC2	P956-9
45	DEC4	P956-8
46	A1	P956-1
47	A2	P956-2
48	A3	P956-3
49	A4	P956-4
50	Spare	

**CONDITIONER BOARD
J1100 PIN ASSIGNMENTS**

PIN	DESCRIPTION	TO/FROM
1	ALARM Light	P1598-2
2	PULSE ALARM On/Off Switch	S1532
3	LOW RATE LIMIT Readout Push Switch	P1133-7
4	RATE ALARM OFF Switch	P1133-4
5	LOW RATE LIMIT R1515 (CW)	P1133-3
6	LOW RATE LIMIT R1515 (slider)	P1133-2
7	HIGH RAGE LIMIT Readout Push Switch	P1134-4
8	HIGH RATE LIMIT R1505 (slider)	P1134-2
9	ALARM RESET	P1159-5, S1559
10	PRESSURE ZERO READOUT PUSH Switch	P1171-1, S765
11	Rate Alarm SOURCE Switch	P1134-3, P1520-1, P1510, S1510
12	Rate Alarm SOURCE Switch	P1520-3, P1510-3, S1510
13	Rate Alarm SOURCE Switch	P1520-5, P1521-5, S1510
14	Apnea DELAY Switch	P1564-2, P1554-2, S1554
15	APNEA ALARM Switch	P1564-4, P1554-4, S1554
16	Selected Trig	U1706B-5
17	Alarm Ext Out	
18	Spare	
19	Spare	
20	Skip Resp	J400-21, P2400-32
21	Resp Wave (0.5 V/Cm)	J400-29, U439A-1, P1597-6
22	Transducer (Skip A/V)	U739B-4, P2400-21
23	Transducer (Selected Press Skip)	CR1163
24	NC (A Wave Scaled)	J600-24, P2400-20, P635-6
25	Pulse Wave	J600-26
26	Press Wave Scaled	J600-28, R1202
27	Sample (DVM)	J900-10, U1177B-11, Q1043
28	Update (DVM)	J900-22
29	DP2	
30	+2.5 V Reference	
31	Ground #2	
32	-12 V	
33	-7 V	
34	+7V	
35	+12 V	
36	LOW RATE LIMIT R1515 (CCW)	P1133-1
37	Spare	
38	HIGH RATE LIMIT R1505 (CCW)	P1134-1
39	Press Wave Scaled	U1175-4
40	PRESSURE ZERO READOUT PUSH Switch	P1171-2
41	Rate Alarm SOURCE Switch	P1520-2, P1510-2, S1510
42	Rate Alarm SOURCE Switch	P1520-4, P1510-4, S1510
43	Apnea DELAY Switch	P1564-1, P1554-1, S1554
44	APNEA ALARM Switch	P1564-3, P1554-3, S1554
45	AUDIO (Alarm)	P1731-3, R1731
46	Low Batt/Monitor On	U2033-6
47	Alarm Ext Reset	
48	Ground #1	
49	-ECG Wave	J100-29, U215C-8, P2400-24
50	Resp Trig	J400-23, CR1729
51	Press/Pulse Trig	J600-12, U1632C-11
52	Transducer (Skip A)	J600-15, P2400-4
53	Pulse/Pressure	J600-18, U1711C-6, J400-25
54	A/V Wave Scaled	J600-25, U872C-8, P635-5, P2400-3
55	Pressure Wave (A/V)	J600-27, U872D-14
56	Press/Pulse Wave	J600-29, S605B
57	Sign Enable	U1133C-10, J900-21
58	Blanking	U1180-3, J900-23
59	DVM In	U1223D-10, J900-28
60	DVM Com	Gnd #1, J900-29

**P2400/P2401
PIN ASSIGNMENTS**

PIN	DESCRIPTION	TO/FROM
1	Alarm Ext Out (15 mA)	J1100-17
2	Alarm Reset	J1100-47
3	A/V Wave Scaled	J1100-54, J600-25, U872C-8, P635-5
4	Skip A	J1100-52, J600-15
5	Skip Temp A	U1406D-14
6	Heart Rate Overrange	U1326B-5
7	°F/°C	R1427 °C Cal
8	A/V Wave (Pulse Wave)	J1100-55 or 56 via P1120
9	Temp A (DVM, 10 mV/deg)	U1406B-7
10	Diast (DVM, 10 mV/mmHg)	U1236D-14
11	RATE (DVM, 10 mA/bpm)	U1335B-7
12	DVM Common	Ground #1, J1100-48
13	Low Batt/Monitor On	J1100-46, U2033-6
14	Temp B Overrange	U1457C-10
15	Skip Temp B	U1466A-1
16	Temp B (DVM, 10 mV/deg)	U1466C-8
17	+7 V	
18	A/V Wave Scaled	J1100-24, J600-24, NC in Standard 413
19	Resp Wave (0.5 V/Cm)	J400-29, U439A-1, J1100-21
20	PULSE WAVE	J1100-25, J600-26
21	Skip A/V	P1100-22, U739B-4
22	A/V Overrange	CR1122, CR1124,
23	Temp A Overrange	U1457D-11
24	-ECG Wave	J100-29, U215C-8, J1100-49
25	Wave Common	Ground #2, J1100-31
26	Syst (DVM, 10 mV/mmHg)	U1236A-1
27	Mean (DVM, 10 mV/mmHg)	U1206A-1
28	Press/Pulse Trig	NC
29	Press/Pulse	U1451B-4
30	Alarm	U1151D-11
31	Resp Rate Overrange	U1326A-13
32	Skip Resp	J400-21, J1100-20
33	RESP Rate (DVM, 10 mV/brpm)	U1335A-1
34	Resp Trig	P1100-50, CR1729



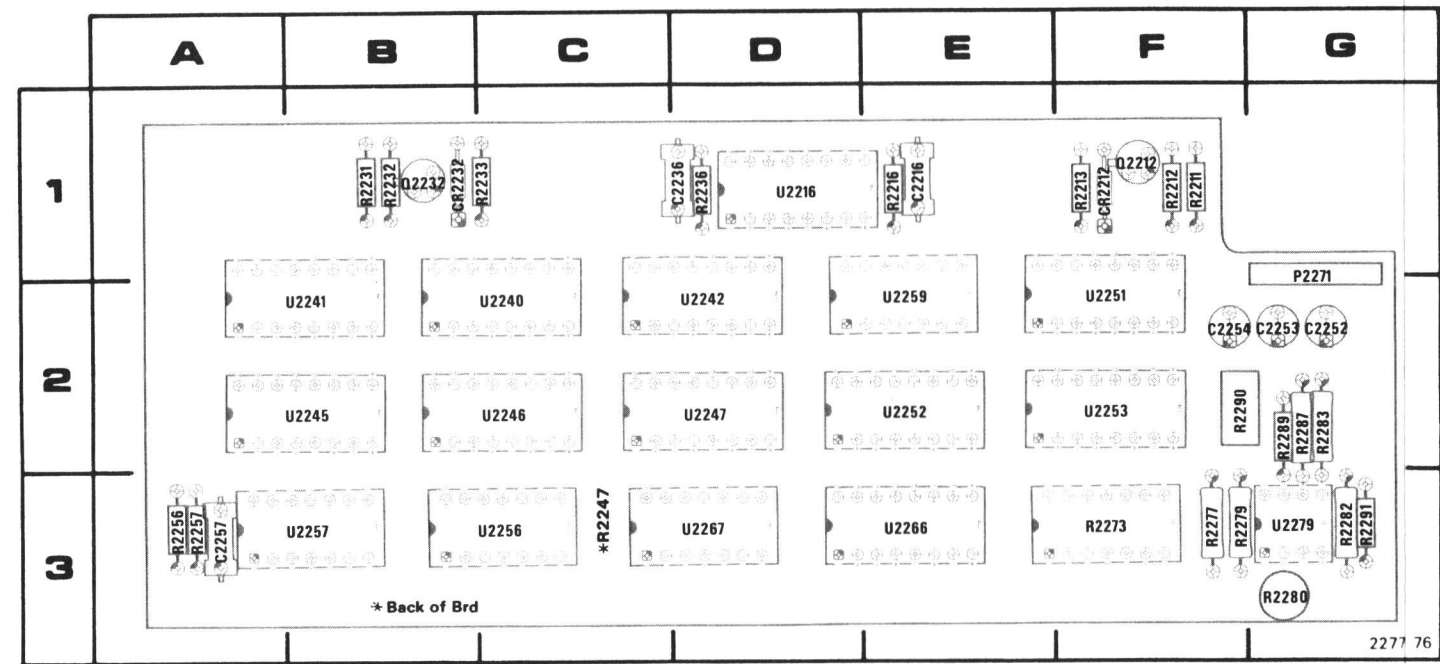
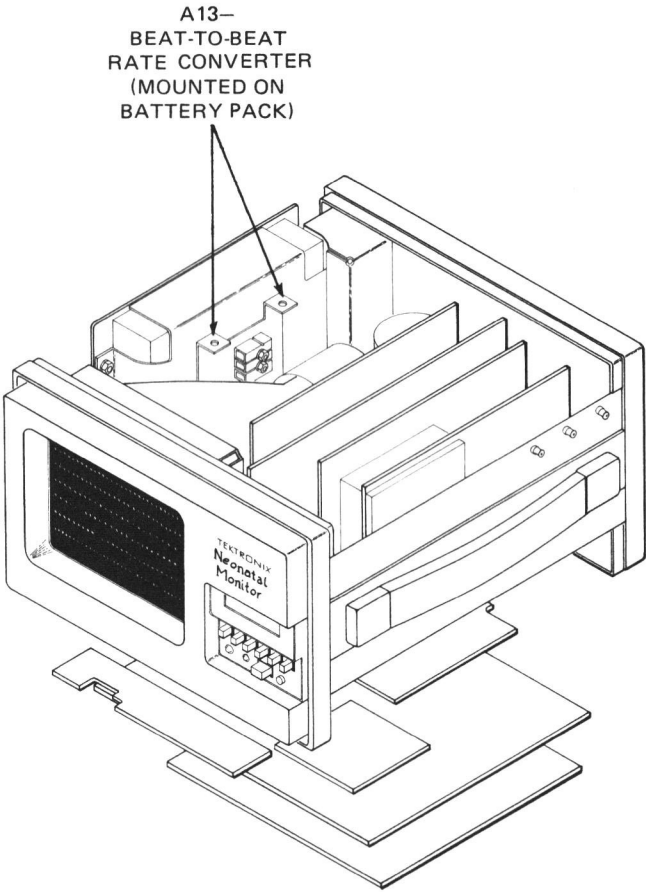


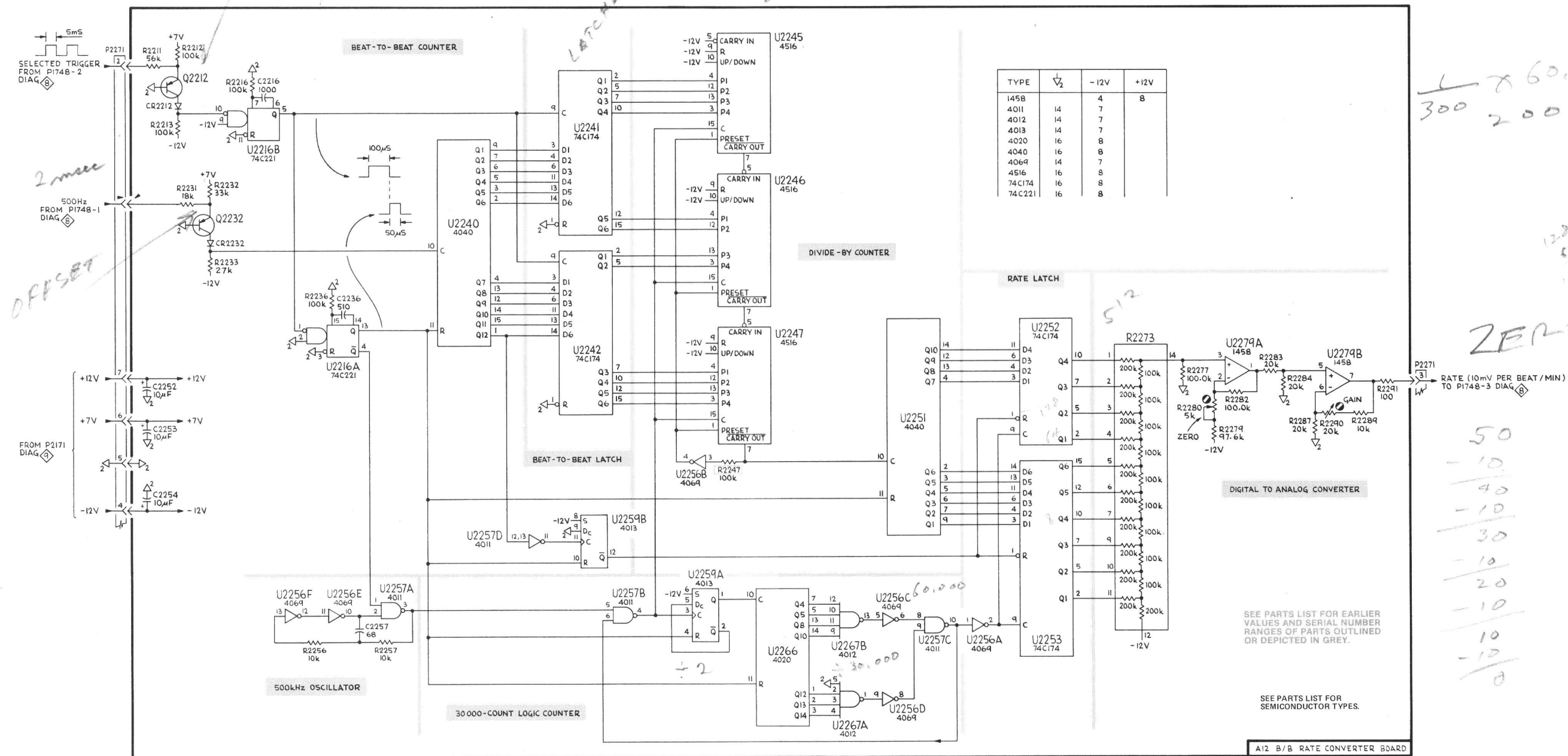
Figure 8-15. A12-Beat-to-Beat Rate Converter board component locations.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C2216	1E	R2211	1F	R2280	3G	U2246	2C
C2236	1D	R2212	1F	R2282	3G	U2247	2D
C2252	2G	R2213	1F	R2283	2G	U2251	2F
C2253	2G	R2216	1E	R2287	2G	U2252	2E
C2254	2F	R2231	1B	R2289	2G	U2253	2F
C2257	3A	R2232	1B	R2290	2F	U2256	3C
		R2233	1C	R2291	3G	U2257	3B
CR2212	1F	R2236	1D			U2259	2E
CR2232	1B	R2247	3C	U2216	1D	U2266	3E
		R2256	3A	U2240	2C	U2267	3D
P2271	1G	R2257	3A	U2241	2B	U2279	3G
		R2273	3F	U2242	2D		
Q2212	1F	R2277	3F	U2245	2B		
Q2232	1B	R2279	3F				



H = 0V
L = -12V

60,000 msec/min
100 BPM = 600 msec
600 msec is period.
1 period is rate
600 msec : 300
2 msec



TYPE	V ₂	-12V	+12V
1458	14	4	8
4011	14	7	
4012	14	7	
4013	14	7	
4020	16	8	
4040	16	8	
4069	14	7	
4516	16	8	
74C174	16	8	
74C221	16	8	

60,000 :
300 200

ZERO

50
-10
40
-10
30
-10
20
-10
10
-10
0

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

A12 B/B RATE CONVERTER BOARD

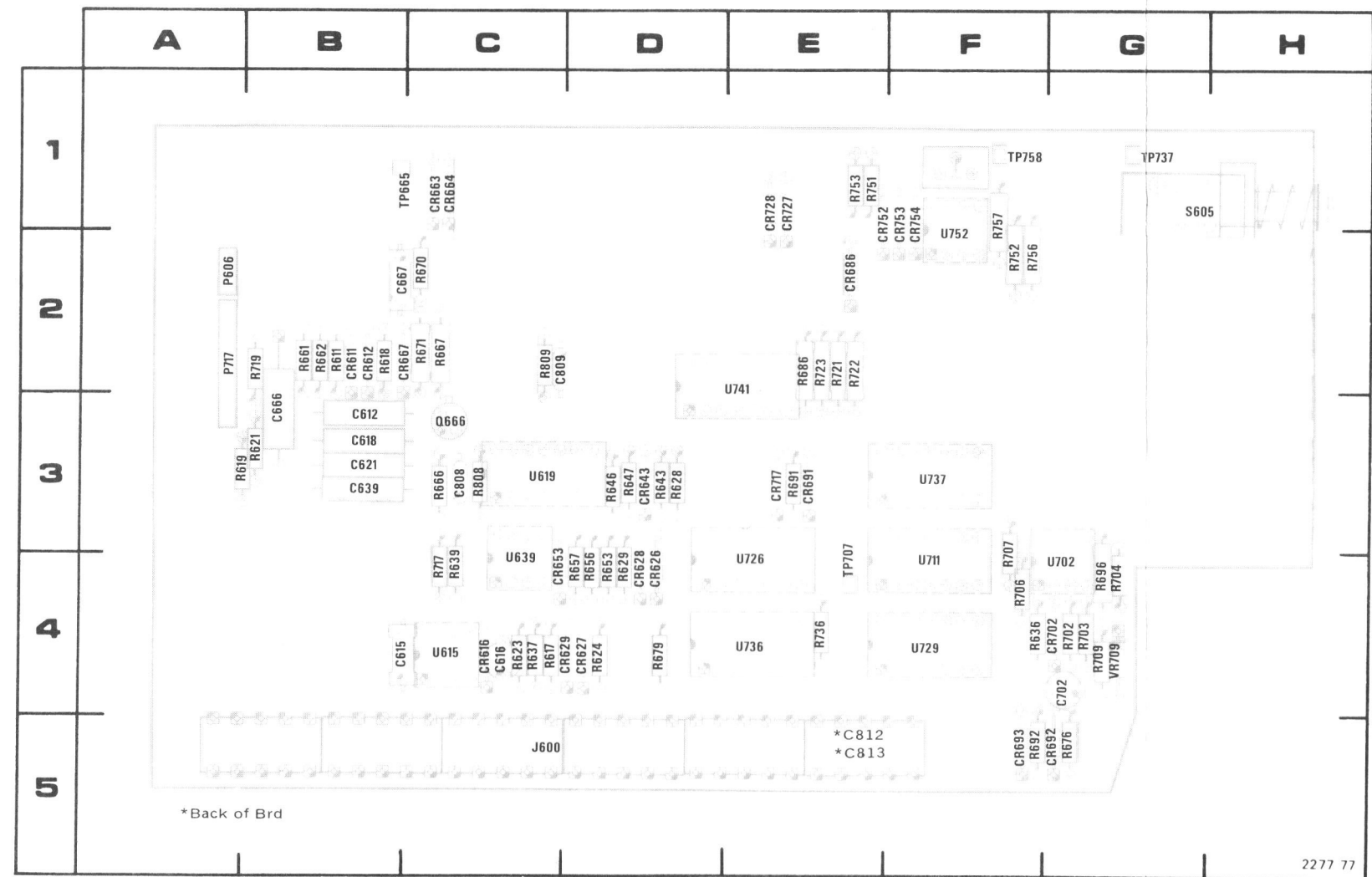
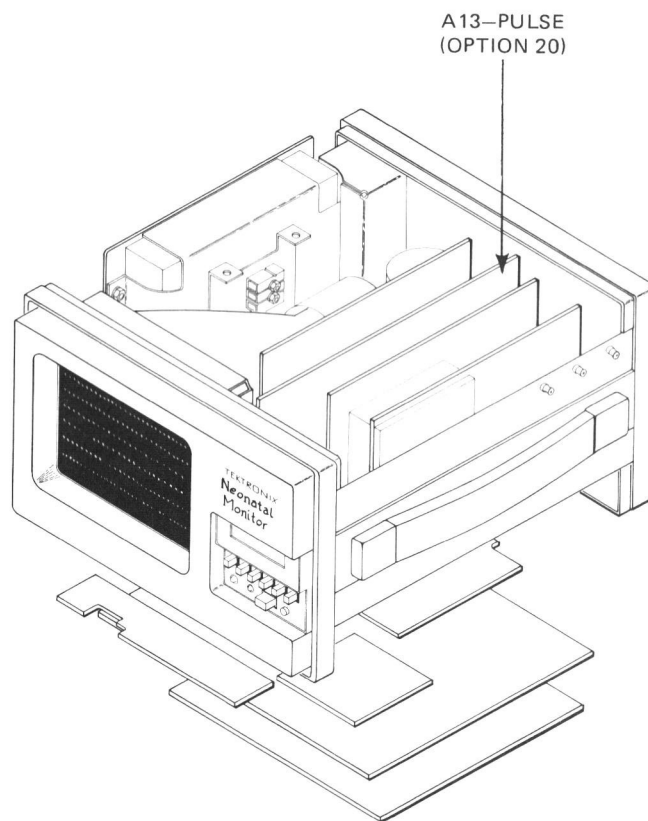


Figure 8-16. A13-Pulse board component locations (Option 20).

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C612	3B	CR753	1F	R679	4D
C615	4B	CR754	1F	R686	2E
C616	4C			R691	3E
C618	3B	J600	5C	R692	5F
C621	3B			R696	3G
C639	3B	P606	2A	R702	4G
C666	3B	P717	2A	R703	4G
C667	2B			R704	4G
C702	4G	Q666	3C	R706	4F
C807	2C			R707	4F
C808	3C	R611	2B	R709	4G
C809	2C	R617	4C	R717	4C
C812	5E	R618	2B		
C813	5E	R619	3B	S605	1H
		R621	3B		
CR611	2B	R622	2B	TP665	1C
CR612	2B	R623	4C	TP707	4E
CR616	4C	R624	4D	TP737	1G
CR626	4D	R628	3D	TP758	1F
CR627	4D	R629	4D		
CR628	4D	R636	4F	U615	4C
CR629	4D	R637	4C	U619	3C
CR643	3D	R639	4C	U639	4C
CR653	4C	R643	3D	U702	4G
CR663	1C	R646	3D	U711	4F
CR664	1C	R647	3D	U726	4E
CR667	2B	R653	4D	U729	4F
CR686	2E	R656	4D	U736	4E
CR691	3E	R657	4D	U737	3F
CR692	5G	R661	2B	U741	3E
CR693	5F	R662	2B	U752	2F
CR702	4G	R666	3C		
CR717	3E	R667	2C	VR709	4G
CR727	1E	R670	2C		
CR728	1E	R671	2C		
CR752	1E	R676	5G		



VOLTAGE CONDITIONS

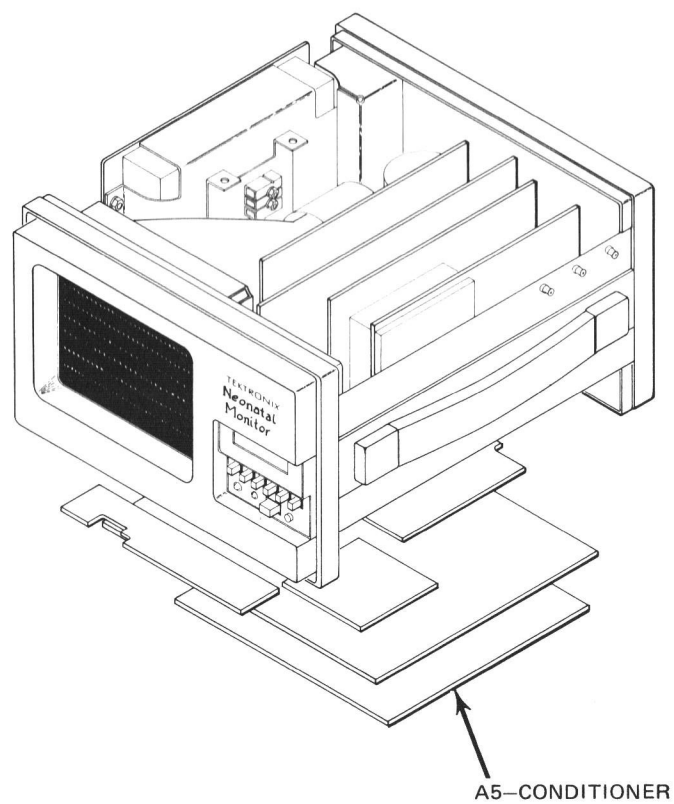
Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground unless noted otherwise.





Figure 8-17. A5-Conditioner board component locations (Option 20).

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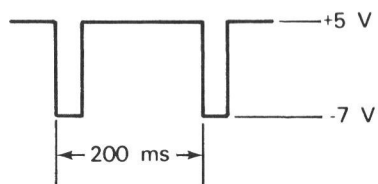
VOLTAGE AND WAVEFORM CONDITIONS

Voltages are design-center values and may vary from measured values. Voltages are referenced to chassis ground unless noted otherwise.

Waveforms are idealized and may vary from actual test-oscilloscope waveforms.

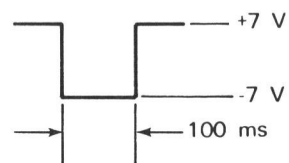
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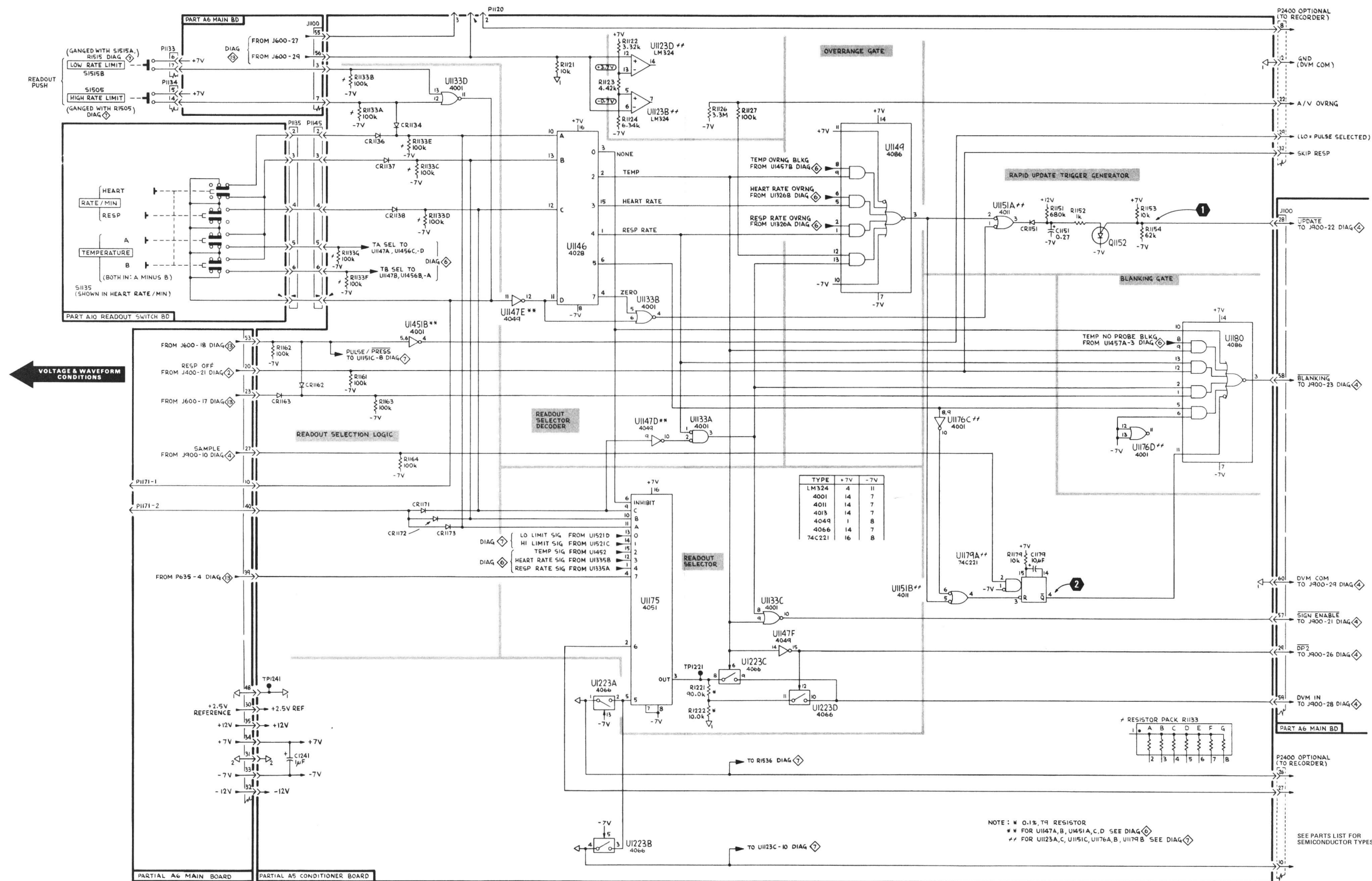
DURING OVERRANGE
AND PUSH-TO-READ
FUNCTIONS ONLY

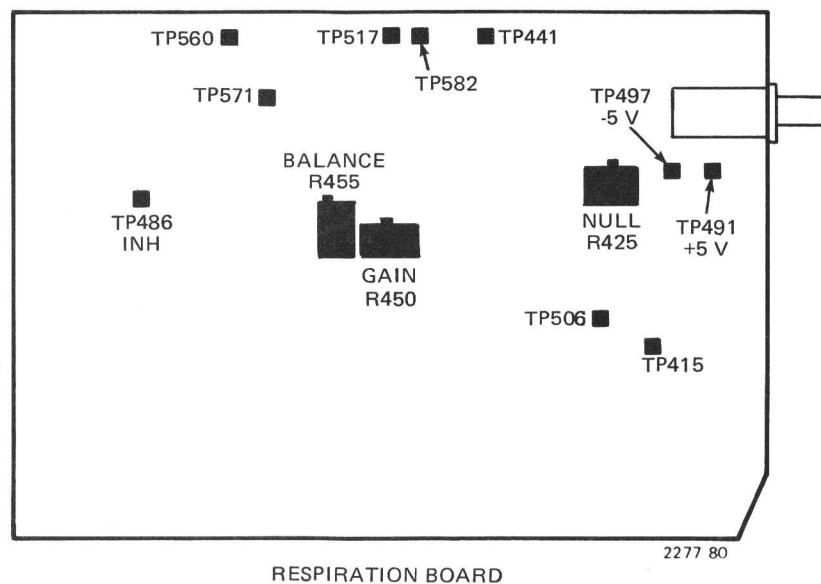
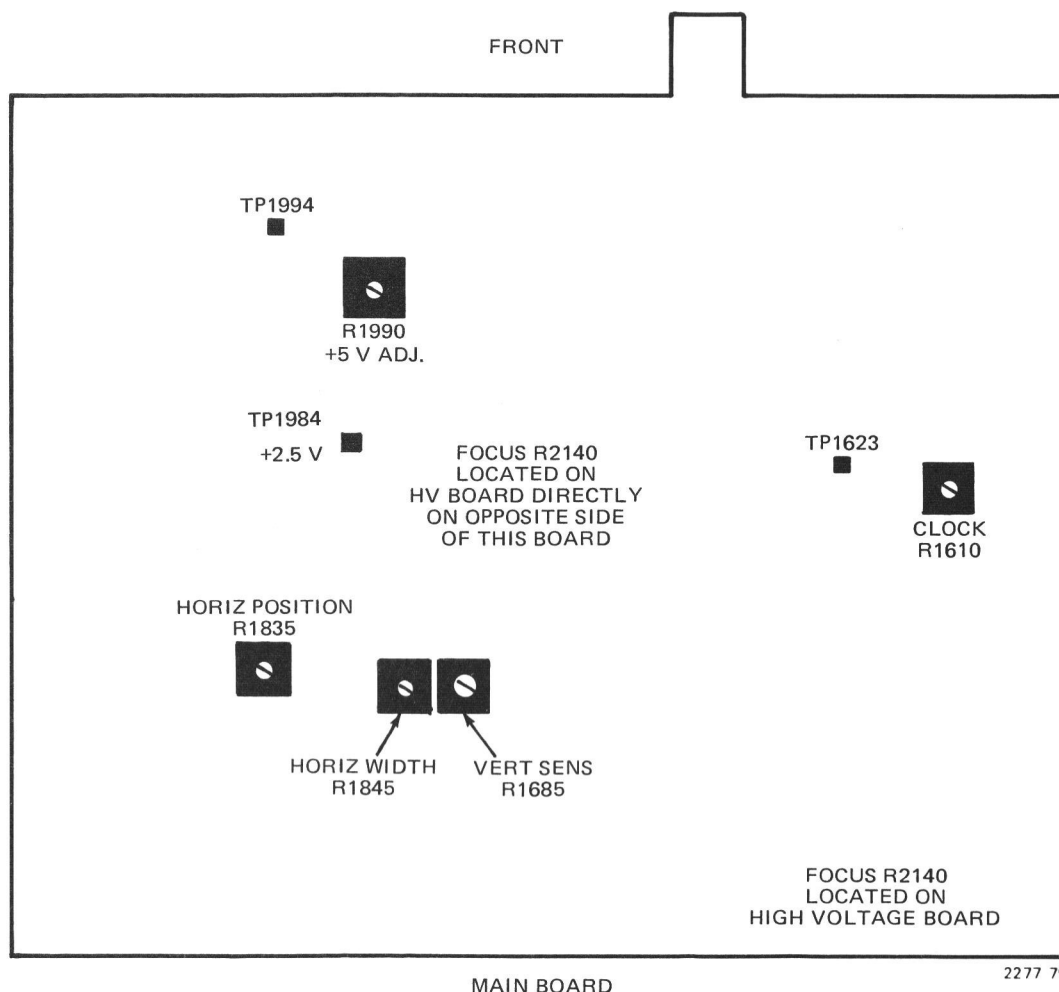


2

DURING OVERRANGE
AND SYST/DIAGN
SELECTION ONLY







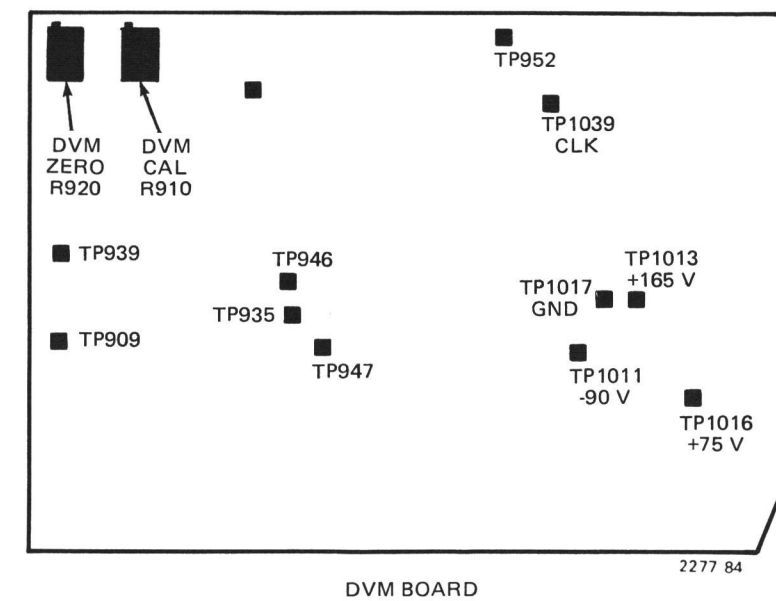
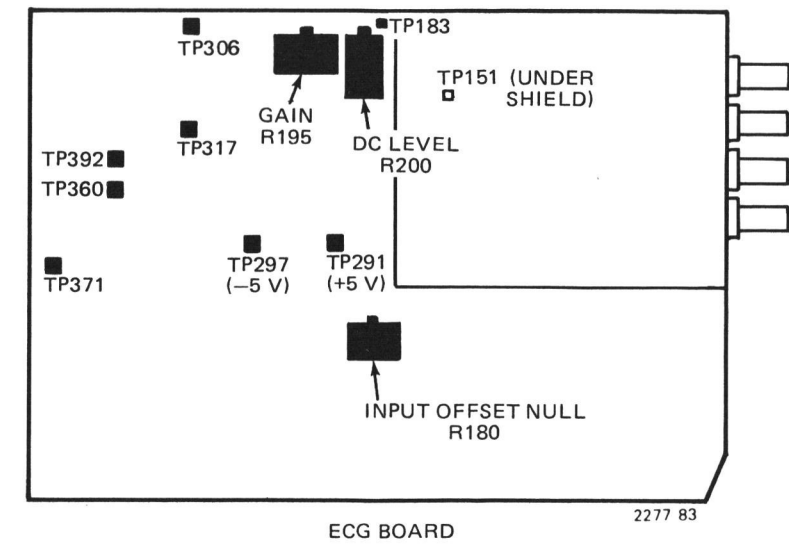
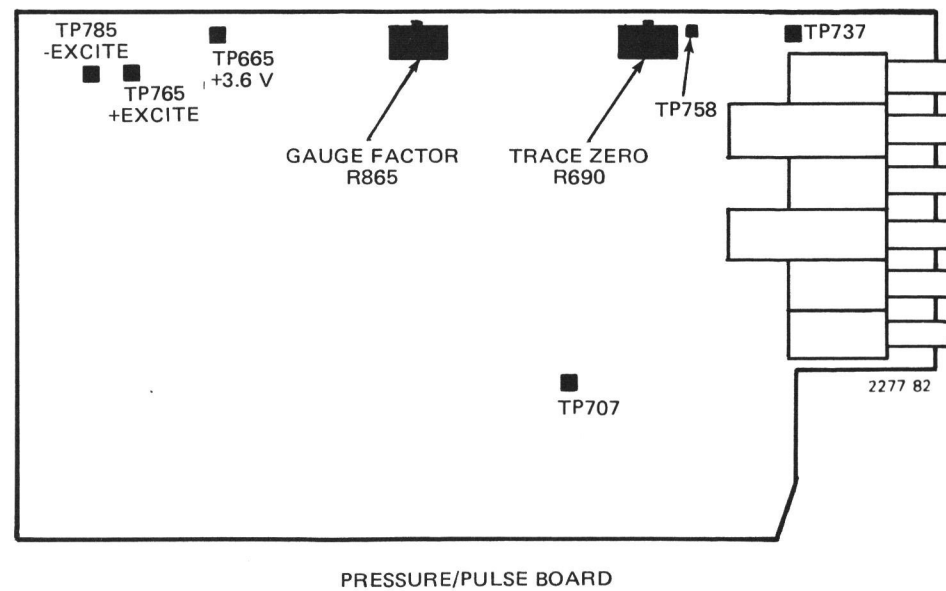
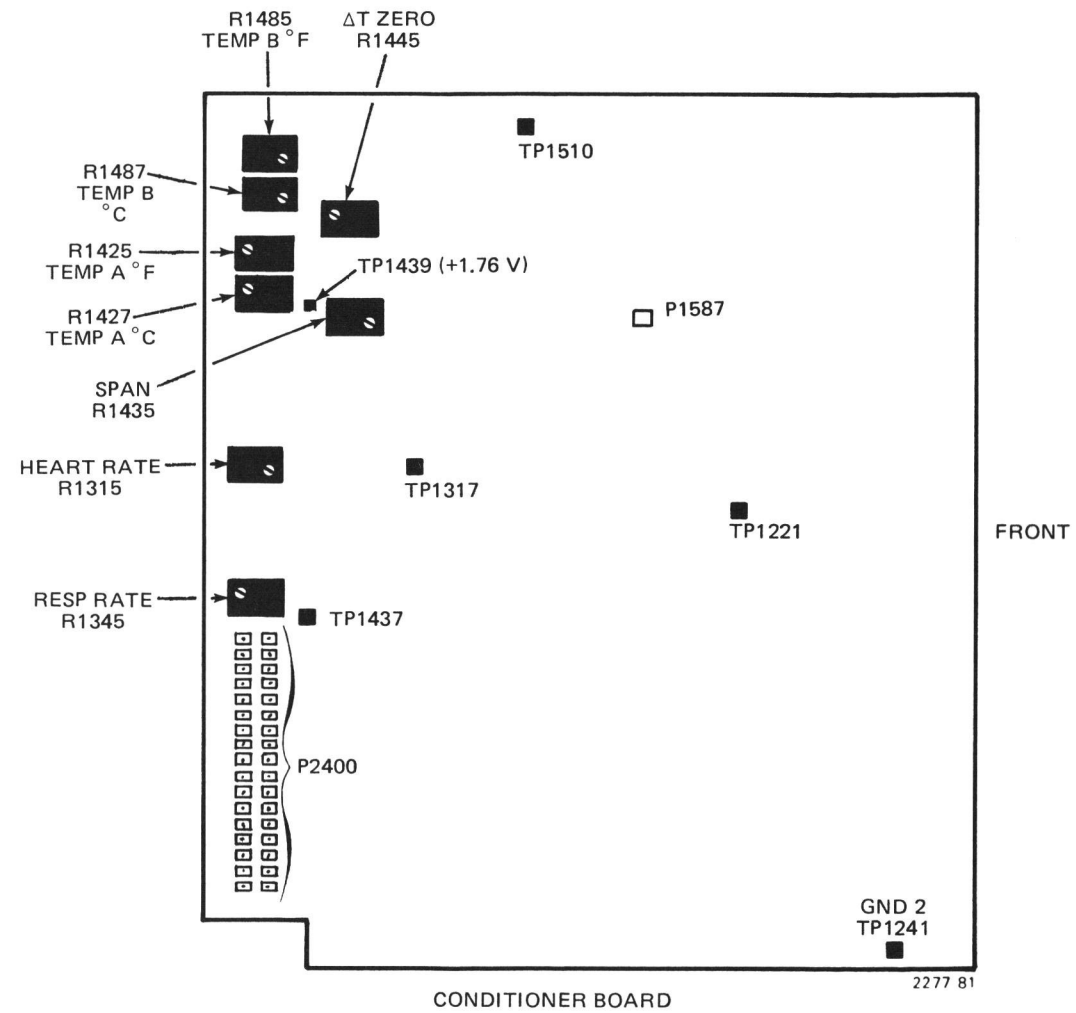


Figure 8-18. Test point and adjustment locations.

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REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5           Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    ---*---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    ---*---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    ---*---
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---*--- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

INCH	ELECTRN	IN	INCH	SE	SINGLE END
NUMBER SIZE	ELEC	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ELECT	INSUL	INSULATOR	SEMICON	SEMICONDUCTOR
ADPTR	ELECTLT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ELEM	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	EPL	MACH	MACHINE	SKT	SOCKET
ASSEM	EQPT	MECH	MECHANICAL	SL	SLIDE
ASSY	EXT	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	FIL	NIP	NIPPLE	SLVG	SLEEVING
ATTENUATOR	FLEX	NON WIRE	NOT WIRE WOUND	SPR	SPRING
AWG	FLH	OBD	ORDER BY DESCRIPTION	SO	SQUARE
BD	FLTR	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRKT	FR	OVH	OVAL HEAD	STL	STEEL
BRS	FRAME or FRONT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BRZ	FASTENER	PL	PLAIN or PLATE	T	TUBE
BUSHG	FT	PLSTC	PLASTIC	TERM	TERMINAL
CAB	FXD	PN	PART NUMBER	THD	THREAD
CAP	GSKT	PNH	PAN HEAD	THK	THICK
CER	HDL	PWR	POWER	TNSN	TENSION
CHAS	HEX	RCPT	RECEPTACLE	TPG	TAPPING
CKT	HEX HD	RES	RESISTOR	TRH	TRUSS HEAD
COMP	HEX SOC	RGD	RIGID	V	VOLTAGE
CONN	HLCP	RLF	RELIEF	VAR	VARIABLE
COV	HLEXT	RTNR	RETAINER	W/	WITH
CPLG	HV	SCH	SOCKET HEAD	WSHR	WASHER
CRT	IC	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DEG	ID	SCR	SCREW	XSTR	TRANSISTOR
DWR	IDENT				
	IMPLR				

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUSS DRIVE	BEAVERTON, OREGON 97005
000EB	AIR-O-PLASTIK	150 FIELDCREST AVENUE	EDISON, NJ 08817
000FB	CALIFORNIA EASTERN LABORATORIES	3005 DEMOCRACY WAY	SANTA CLARA, CA 95050
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
12136	PHILADELPHIA HANDLE COMPANY, INC.	1643 HADDON AVENUE	CAMDEN, NJ 08103
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22670	G.M. NAMEPLATE, INC.	2040 15TH AVENUE WEST	SEATTLE, WA 98119
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
50060	NDM CORPORATION	3040 RIVER ROAD	DAYTON, OH 45439
54516	NATIONAL CABLE MOLDING CORPORATION	136 SAN FERNANDO ROAD	LOS ANGELES, CA 90031
57771	STIMPSON, EDWIN B., CO., INC.	900 SYLVAN AVENUE	BAYPORT, NY 11705
70318	ALLMETAL SCREW PRODUCTS CO., INC.	821 STEWART AVE.	GARDEN CITY, NY 11530
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74545	HUBBELL HARVEY, INC.	584 DERBY MILFORD ROAD	ORANGE, CT 06477
77132	DOT FASTENER CO., A UNITED-CARR DIV. OF TRW INC.	ROUND HOUSE INDL PK, PO BOX 710	WATERBURY, CT 06720
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
77969	RUBBERCRAFT CORP. OF CALIF., LTD.	1800 W. 220TH ST.	TORRANCE, CA 90507
78189	ILLINOIS TOOL WORKS, INC.	ST. CHARLES ROAD	ELGIN, IL 60120
79807	SHAKEPROOF DIVISION	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	WROUGHT WASHER MFG. CO.	P O BOX 500	BEAVERTON, OR 97077
82647	TEKTRONIX, INC.		
	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86445	PENN FIBRE AND SPECIALTY CO., INC.	2032 E. WESTMORELAND ST.	PHILADELPHIA, PA 19134
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
88245	LITTON SYSTEMS, INC., USECO DIV.	13536 SATICOY ST.	VAN NUYS, CA 91409
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	348-0414-00		2		BUMPER, PLASTIC: 0.500 DIA, TEK BLUE	80009	348-0414-00
-2	355-0184-00		4		STUD, SNAP FSTNR: (ATTACHING PARTS FOR EACH)	77132	BS-10370
-3	211-0105-00		1		SCREW, MACHINE: 4-40 X 0.188" 100 DEG, FLH STL - - - * - - -	83385	OBD
-4	390-0581-00		1		CAB., WRAPAROUND: TOP	80009	390-0581-00
-5	342-0212-00		1		INSULATOR, FILM: CIRCUIT BOARD, MYLAR (ATTACHING PARTS)	80009	342-0212-00
-6	211-0565-00		4		SCREW, MACHINE: 6-32 X 0.250 INCH, TRH STL - - - * - - -	83385	OBD
-7	348-0414-00		2		BUMPER, PLASTIC: 0.500 DIA, TEKBLUE	80009	348-0414-00
-8	348-0089-00		4		BUMPER, PLASTIC: BLACK VINYL	80009	348-0089-00
-9	348-0380-01		4		FOOT, CABINET: TEK BLUE NYLON (ATTACHING PARTS FOR EACH)	80009	348-0380-01
-10	211-0097-00		2		SCREW, MACHINE: 4-40 X 0.312 INCH, PNH STL - - - * - - -	83385	OBD
-11	348-0282-00		1		FLIPSTAND, CAB.: 3.438 H, SST	80009	348-0282-00
-12	390-0363-00	B010100 B031349	1		COVER, MONITOR: BOTTOM, 0.040 AL	80009	390-0363-00
	390-0363-03	B031350	1		COVER, MONITOR: BOTTOM, 0.040 AL (ATTACHING PARTS)	80009	390-0363-03
-13	211-0565-00		4		SCREW, MACHINE: 6-32 X 0.250 INCH, TRH STL - - - * - - -	83385	OBD
-14	200-2136-00		1		DOOR, ACCESS: FRONT, NEONATAL, W/HARDWARE	80009	200-2136-00
	200-2137-00		1		DOOR, ACCESS: FRONT, ADULT W/HDW, PLASTIC (OPTION 22 ONLY)	80009	200-2137-00
	-----				(ATTACHING PARTS)		
-15	211-0034-00		4		SCREW, MACHINE: 2-56 X 0.50 INCH, PNH - - - * - - -	83385	OBD
-16	337-2405-00		1		SHLD, IMPLOSION: 414 MOD 4A	22670	OBD
	337-2408-00		1		SHLD, IMPLOSION: (OPTION 20 ONLY)	80009	337-2408-00
	337-2475-00		1		SHLD, IMPLOSION: (OPTION 22 ONLY)	80009	337-2475-00
-17	334-3037-00		1		MARKER, IDENT: MARKED 413	22670	OBD
	334-3038-00		1		MARKER, IDENT: OPTION 20	80009	334-3038-00
-18	378-0100-00		1		FILTER, LIGHT: AMB, 2.4 X 0.85 X 0.03	80009	378-0100-00
-19	331-0433-00		1		MASK, READOUT: 413/413 OPT 20	80009	331-0433-00
-20	-----		1		LIGHT IND: (SEE DS1585 EPL)		
-21	333-2305-00		1		PANEL, FRONT: 413	80009	333-2305-00
	333-2305-01		1		PANEL, FRONT: OPTION 20 (OPTION 20 ONLY)	80009	333-2305-01
	-----				(ATTACHING PARTS)		
-22	211-0025-00		2		SCREW, MACHINE: 4-40 X 0.375 100 DEG, FLH STL - - - * - - -	83385	OBD
-23	366-1495-00		6		KNOB: GRAY	80009	366-1495-00
	213-0153-00		-		EACH KNOB INCLUDES:		
	426-1072-00		1		SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-24	-----		19		FRAME, PUSH BTN: PLASTIC	80009	426-1072-00
-25	-----		1		RES., VAR, NONWIR: (SEE R1733 EPL) (ATTACHING PARTS)		
-26	210-0583-00		1		NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20224-402
-27	210-0940-00		1		WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL - - - * - - -	79807	OBD
-28	-----		1		RES., VAR NONWIR: (SEE R635 EPL) (ATTACHING PARTS)		
-29	210-0583-00		1		NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20224-402
-30	210-0940-00		1		WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL - - - * - - -	79807	OBD
-31	-----		1		RES., VAR NONWIR: (SEE R470 EPL) (ATTACHING PARTS)		
-32	210-0583-00		1		NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20224-402
-33	210-0940-00		1		WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL - - - * - - -	79807	OBD

Replaceable Mechanical Parts—413

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-34	-----	-----	1		RES.,VAR NONWIR:(SEE R212 EPL) (ATTACHING PARTS)		
-35	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-36	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
					- - - * - - -		
-37	366-0261-00	B010100 B031174	1		KNOB:0.312 OD X 0.406 INCH LONG	80009	366-0261-00
	366-0261-01	B031175	1		KNOB:	80009	366-0261-01
	214-0949-00		1		. SPR,HLCL,TRSN:0.282" OD X 0.125" LONG	80009	214-0949-00
-38	-----	-----	1		RES.,VAR NONWIR:(SEE R765 EPL) (ATTACHING PARTS)		
-39	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-40	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-41	210-0046-00		1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-42	-----	-----	1		RES.,VAR NONWIR:(SEE R1515 EPL) (ATTACHING PARTS)		
-43	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-44	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
					- - - * - - -		
-45	-----	-----	1		RES.,VAR NONWIR:(SEE R1505 EPL) (ATTACHING PARTS)		
-46	210-0583-00		1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-47	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
					- - - * - - -		
-48	333-2303-00		1		PANEL,FRONT:	80009	333-2303-00
	333-2363-00		1		PANEL,FRONT:	80009	333-2363-00
	333-2304-00		1		PANEL,FRONT:	80009	333-2304-00
-49	200-0935-00		2		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-50	352-0157-00		2		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-51	-----	-----	1		LAMP LED:YELLOW(SEE DS470 EPL)		
-52	-----	-----	1		LAMP LED:GREEN(SEE DS1725 EPL)		
-53	-----	-----	1		CKT BOARD ASSY:SWEEP SW(SEE A9 EPL) (ATTACHING PARTS)		
-54	211-0541-00		2		SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-55	366-1559-00		8		. CKT BOARD ASSY INCLUDES:	80009	366-1559-00
-56	220-0802-00		2		. NUT BLOCK:0.325 X 0.4 X0.19,(2)0-80 THRU (ATTACHING PARTS FOR EACH)	80009	220-0802-00
-57	211-0186-00		2		. SCREW,MACHINE:0-80 X 0.125,FILH,SST,SLOT	12360	00A008AHBUU01
					- - - * - - -		
-58	-----	-----	2		. SWITCH,PUSH:(SEE S1510 & S1956 EPL)		
-59	-----	-----	1		. SWITCH,PUSH:(SEE S1782 EPL)		
-60	-----	-----	1		. SWITCH,PUSH:(SEE S1554 EPL)		
-61	361-0542-00		14		. SPACER,SWITCH:PLASTIC	71590	J-64281
-62	131-0589-00		22		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-63	-----	-----	1		CKT BOARD ASSY:READOUT SW(SEE A10 EPL) (ATTACHING PARTS)		
-64	211-0541-00		2		SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-65	220-0802-00		2		. CKT BOARD ASSY INCLUDES:	80009	220-0802-00
-66	211-0186-00		2		. NUT BLOCK:0.325 X 0.4 X0.19,(2)0-80 THRU (ATTACHING PARTS FOR EACH)	12360	00A008AHBUU01
					- - - * - - -		
-67	366-1559-00		6		. PUSH BUTTON:GRAY	80009	366-1559-00
	-----	-----	-		. (STANDARD AND OPTION 22 ONLY)		
	366-1559-00		4		. PUSH BUTTON:GRAY	80009	366-1559-00
	-----	-----	-		. (OPTION 20 ONLY)		
-68	366-1489-23		1		. PUSH BUTTON:GRAY--RESET	80009	366-1489-23
-69	384-1136-00		1		. EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-70	-----	-----	1		. SWITCH,PUSH:(SEE S1135 EPL)		
-71	-----	-----	-		. SWITCH,PUSH:(SEE S1559 EPL)		
-72	361-0542-00		6		. SPACER,SWITCH:PLASTIC	71590	J-64281



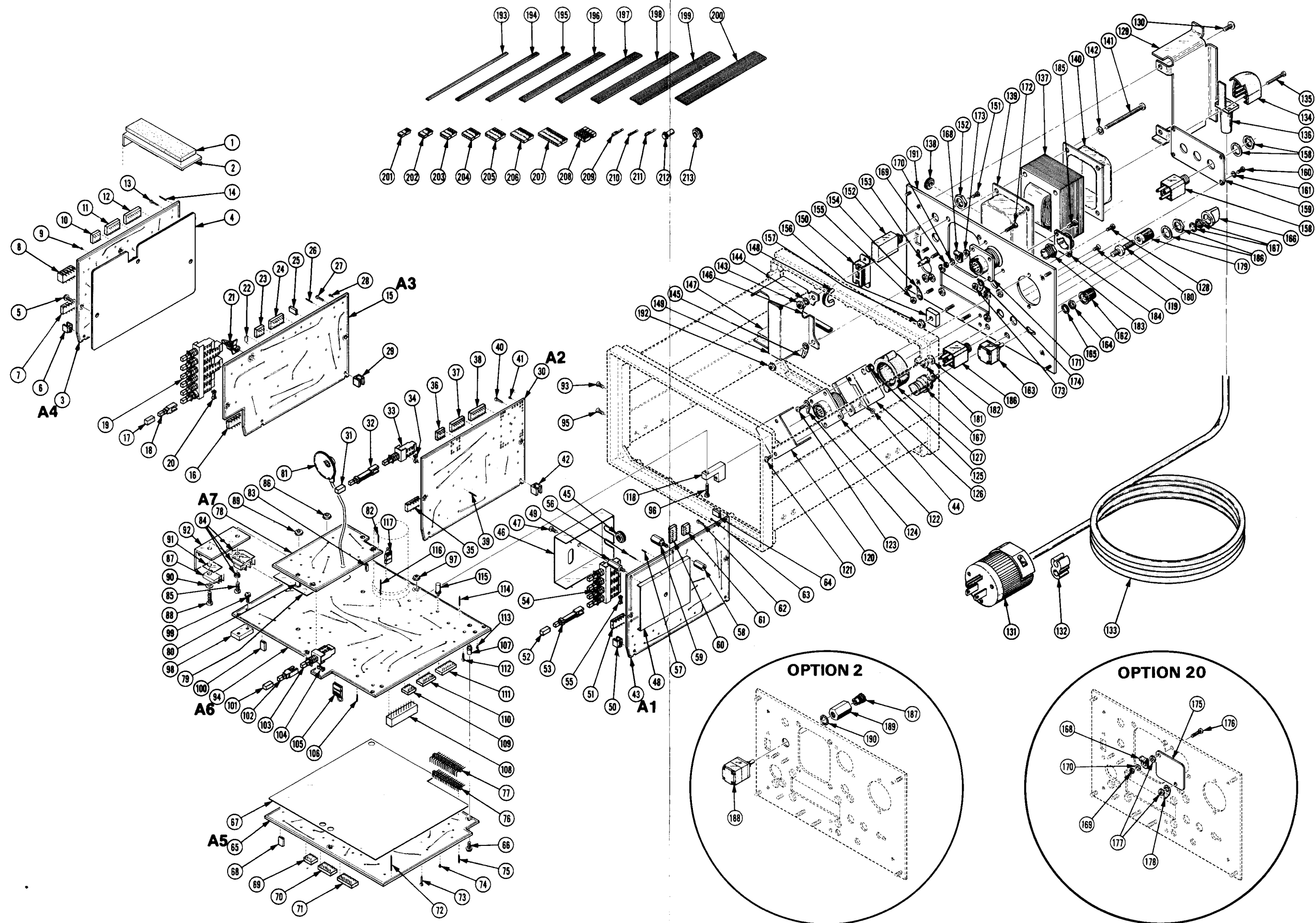


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-73	131-0608-00		12		1 . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-74	-----		1		1 . LT EMITTING DIO:RED/GREEN(SEE DS2039 EPL)		
-75	-----		1		1 . LT EMITTING DIO:RED(SEE DS1727 EPL)		
	175-2096-00		1		1 . CA ASSY,SP,ELEC:6,26 AWG,4.5 L	80009	175-2096-00
-76	131-0707-00		6		6 . . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-77	175-0829-00		FT		1 . . WIRE,ELECTRICAL:6 WIRE RIBBON	08261	SS-0626-710610C
-78	352-0164-00		1		1 . . CONN BODY,PL,EL:6 WIRE BLACK	80009	352-0164-00
	175-2108-00		1		1 . CA ASSY,SP,ELEC:5,26 AWG,3.5 L	80009	175-2108-00
-79	131-0707-00		5		5 . . CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
-80	175-0828-00		FT		1 . . WIRE,ELECTRICAL:5 WIRE RIBBON	08261	OBD
-81	352-0163-01		1		1 . . CONN BODY,PL,EL:5 WIRE BROWN	80009	352-0163-01
-82	-----		1		1 CKT BOARD ASSY:DISPLAY(SEE A8 EPL) (ATTACHING PARTS)		
-83	211-0097-00		2		2 SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
	-----				- - - - *		
	-----				- CKT BOARD ASSY INCLUDES:		
-84	136-0676-00		38		1 . SOCKET,PIN TERM:FOR 0.016-0.029 DIA PIN	00779	51965-1
-85	136-0673-00		1		1 . SKT,PL-IN ELEK:READOUT LAMPS,38 CONTACTS	80009	136-0673-00
-86	131-0608-00		19		1 . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-87	386-3714-00		1		1 SUBPANEL,FRONT:413 (ATTACHING PARTS)	80009	386-3714-00
-88	210-0586-00		4		4 NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
	-----				- - - - *		
-89	348-0352-00		4		4 PAD,CUSHIONING:	80009	348-0352-00
	136-0551-00	B010100 B029999	1		1 SOCKET,PLUG-IN:CRT	80009	136-0551-00
	136-0551-01	B030000 B030649	1		1 SKT,PL-IN ELEK:CRT,11 CONT W/LEADS	80009	136-0551-01
	136-0551-03	B030650	1		1 SKT,PL-IN ELEK:ELCTR N TUBE,11 CONT,W/LEADS	80009	136-0551-03
-90	136-0669-00		1		1 . SKT,PL-IN ELEK:CRT,5 CONTACTS	000FB	S7-502B-49
-91	352-0201-00		1		1 . CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0201-00
-92	131-0621-00		5		5 . CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
-93	175-0828-00		FT		1 . WIRE,ELECTRICAL:5 WIRE RIBBON	08261	OBD
-94	343-0429-01		2		2 CUSHION,CRT:REAR,1.0 LONG	80009	343-0429-01
-95	343-0428-00		1		1 CLAMP,LOOP: (ATTACHING PARTS)	80009	343-0428-00
-96	211-0097-00		1		1 SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
	-----				- - - - *		
-97	166-0026-00		1		1 SPACER,SLEEVE:0.375 L X 0.125 ID (ATTACHING PARTS)	71590	P7610-1
-98	211-0126-00	XB020000 B031154	1		1 SCREW,MACHINE:4-40 X 0.625,FLH,SST	70318	OBD
	211-0116-00	B031155	1		1 SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	-----				- - - - *		
-99	343-0427-00		1		1 RTNR,ELCTR N TUB:FRONT (ATTACHING PARTS)	80009	343-0427-00
-100	211-0021-00		3		3 SCREW,MACHINE:4-40 X 1.25 INCH,PNH STL	83385	OBD
	-----				- - - - *		
-101	343-0144-00		1		1 CLAMP,LOOP:0.125 INCH ID,BLK NYLON (ATTACHING PARTS)	95987	1-8-2
	-----				- - - - *		
-102	129-0456-00	B010100 B030799	1		1 SPACER,POST:0.75 L,W/4-40STUD,TAP,BRASS	80009	129-0456-00
	129-0718-00	B030800 B031154X	1		1 SPACER,POST:0.81 L,W/4-40INT-EXT THD	80009	129-0718-00
-103	252-0571-00		FT		1 NEOPRENE EXTR:CHAN,0.234 X 0.156	77969	1353
-104	-----		1		1 ELECTRON TUBE:(SEE V2120 EPL)		
-105	-----		1		1 CKT BOARD ASSY:CONVERTER(SEE A12 EPL)		
	-----		-		(OPTION 5 ONLY) (ATTACHING PARTS)		
-106	211-0116-00		2		2 SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	-----		-		(OPTION 5 ONLY) - - - - *		
	-----				- . CKT BOARD ASSY INCLUDES:		
-107	348-0089-00		1		1 . BUMPER,PLASTIC:BLACK VINYL	80009	348-0089-00
	-----		-		(OPTION 5 ONLY)		
-108	136-0252-04		6		6 . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
	-----		-		(OPTION 5 ONLY)		
-109	136-0269-02		5		5 . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
	-----		-		(OPTION 5 ONLY)		
-110	136-0260-02		11		11 . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
	-----		-		(OPTION 5 ONLY)		
-111	131-0608-00		7		7 . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
	-----		-		(OPTION 5 ONLY)		
-112	136-0514-00		1		1 . SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
	-----		-		(OPTION 5 ONLY)		

Replaceable Mechanical Parts—413

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-	198-3735-00		1		. WIRE SET,ELEC:413 OPT 05	80009	198-3735-00
	-----		-		. (OPTION 5 ONLY)		
-113	175-0825-00		FT		. WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
	-----		-		. (OPTION 5 ONLY)		
-114	175-0827-00		FT		. WIRE,ELECTRICAL:4 WIRE RIBBON	08261	SS-0426-710610C
	-----		-		. (OPTION 5 ONLY)		
-115	352-0162-00		1		. HLD,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	-----		-		. (OPTION 5 ONLY)		
-116	352-0165-00		1		. CONN BODY,PL,EL:7 WIRE BLACK	80009	352-0165-00
	-----		-		. (OPTION 5 ONLY)		
-117	352-0201-02		1		. CONN BODY,PL,EL:5 WIRE RED	80009	352-0201-02
	-----		-		. (OPTION 5 ONLY)		
-118	131-0621-00		4		. CONNECTOR,TERM:22-26 AWG,BRS& CU BE GOLD	22526	46231
	-----		-		. (OPTION 5 ONLY)		
	131-0707-00		7		. CONNECTOR,TERM.:22-26 AWG,BRS& CU BE GOLD	22526	47439
	-----		-		. (OPTION 5 ONLY)		
-119	119-0443-01		1		BATTERY SET:"F" CELL	80009	119-0443-01
	-----		-		(FURNISHED AS A UNIT ONLY)		
					(ATTACHING PARTS)		
-120	211-0101-00		2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
	000-6926-00	XB030850	1		TAG,INFO:MARKED ALERT BTRY CHARGING	80009	000-6926-00
-121	352-0449-00		1		HOLDHOLDER,SPEAKER:	80009	352-0449-00
					(ATTACHING PARTS)		
-122	211-0101-00		1		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-123	-----		1		LOUDSPEAKER,PM:W/CABLE(SEE LS1759 EPL)		
-124	426-1405-01		1		FRAME SECT,CAB.:LEFT	80009	426-1405-01
					(ATTACHING PARTS)		
-125	211-0101-00		4		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-126	131-1371-00		3		TERM,FEEDTHRU:0.478 L X 0.20A DIA,BRASS	80009	131-1371-00
					(ATTACHING PARTS FOR EACH)		
-127	358-0176-00		1		INSULATOR,BSHG:	88245	421472
					- - - * - - -		
-128	344-0098-00		2		CLIP,DECORATIVE:CARRYING HANDLE,STL NP	12136	OBD
					(ATTACHING PARTS FOR EACH)		
-129	213-0089-00		1		SCREW,MACHINE:10-32 X 0.375,HEX HD	80009	213-0089-00
-130	210-0010-00		1		WASHER,LOCK:INT,0.20 ID X0.376" OD,STL	78189	1210-00-00-0541C
					- - - * - - -		
-131	367-0037-00		1		HANDLE,CARRYING:	80009	367-0037-00
-132	426-1404-01		1		FRAME SECT,CAB.:RIGHT	80009	426-1404-01
					(ATTACHING PARTS)		
-133	211-0101-00		4		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-134	252-0603-00		FT		PLASTIC STRIP:0.25 X 0.125 URETHANE FOAM	000EB	OBD
-135	426-0997-03		2		FRAME SECT,CAB.:FRONT & REAR	80009	426-0997-03

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	348-0362-00	B010100 B019999	1		PAD,CUSHIONING:6.0 X 2.0 X 0.25,FOAM	80009	348-0362-00
-1	348-0559-00	B020000	1		PAD,CUSHIONING:3.0 X 1.0 X 0.312,NPRN FOAM	80009	348-0559-00
-2	343-0432-01		1		RETAINER,CKT BD:	80009	343-0432-01
-3	-----		1		CKT BOARD ASSY:DVM(SEE A4 EPL)		
-4	337-2410-00		1		SHIELD,ELEC:CIRCUIT CARD (ATTACHING PARTS)	80009	337-2410-00
-5	211-0116-00		3		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	0BD
-6	214-2440-00		-		. CKT BOARD ASSY INCLUDES:		
-7	136-0461-00		2		. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-8	131-2039-00		4		. SKT,PL-IN ELEC:CKT CARD CONTACT	80009	136-0461-00
-9	136-0252-04		2		. CONN,RCPT,ELEC:CKT CD,10 FEMALE,DOUBLE ROW	22526	65002-075
-10	136-0514-00		66		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-11	136-0269-02		5		. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-12	136-0260-02		7		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-13	214-0579-00		8		. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-14	131-0589-00		13		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-15	-----		2		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-16	136-0461-00		1		CKT BOARD ASSY:PRESSURE/PULSE(SEE A3 EPL)		
-17	366-1559-00		6		. SKT,PL-IN ELEC:CKT CARD CONTACT	80009	136-0461-00
-18	384-1136-00		6		. PUSH BUTTON:GRAY	80009	366-1559-00
-19	-----		6		. EXTENSION SHAFT:0.95 INCH LONG (STANDARD AND OPTION 22 ONLY)	80009	384-1136-00
-20	361-0542-00		1		. SWITCH,PUSH:(SEE S605 EPL)		
-21	-----		5		. SPACER,SWITCH:PLASTIC	71590	J-64281
-22	361-0542-00		-		(OPTION 22 ONLY)		
-23	361-0542-00		6		. SPACER,SWITCH:PLASTIC	71590	J-64281
-24	361-0542-00		-		(STANDARD ONLY)		
-25	361-0542-00		2		. SPACER,SWITCH:PLASTIC	71590	J-64281
-26	361-0542-00		-		(OPTION 20 ONLY)		
-27	386-1895-00		1		. SUPPORT,CKT BD:FOR 0.250 BD HEIGHT,PLSTC	80009	386-1895-00
-28	-----		2		. LINK,TERM,CONNE:(SEE R661 R881)		
-29	136-0514-00		5		. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-30	-----		-		(STANDARD AND OPTION 22 ONLY)		
-31	136-0514-00		4		. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-32	-----		-		(OPTION 20 ONLY)		
-33	136-0269-02		10		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-34	-----		-		(STANDARD AND OPTION 22 ONLY)		
-35	136-0269-02		7		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-36	-----		-		(OPTION 20 ONLY)		
-37	131-0993-00		3		. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-38	-----		-		(STANDARD AND OPTION 22 ONLY)		
-39	131-0993-00		2		. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-40	-----		-		(OPTION 20 ONLY)		
-41	131-0589-00		20		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-42	-----		-		(STANDARD AND OPTION 22 ONLY)		
-43	131-0589-00		11		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-44	-----		-		(OPTION 20 ONLY)		
-45	214-0579-00		6		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-46	-----		-		(STANDARD AND OPTION 22 ONLY)		
-47	214-0579-00		4		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-48	-----		-		(OPTION 20 ONLY)		
-49	136-0252-04		12		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-50	-----		-		(STANDARD AND OPTION 22 ONLY)		
-51	136-0252-04		3		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-52	-----		-		(OPTION 20 ONLY)		
-53	214-2440-00		2		. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-54	-----		-		(STANDARD AND OPTION 22 ONLY)		
-55	-----		1		CKT BOARD ASSY:RESPIRATION(SEE A2 EPL)		
-56	366-1559-00		1		. PUSH BUTTON:GRAY	80009	366-1559-00
-57	384-1099-00		1		. EXTENSION SHAFT:PUSH BUTTON,1.54 INCH LONG	80009	384-1099-00
-58	-----		1		. SWITCH,PUSH:(SEE S405 EPL)		
-59	361-0542-00		2		. SPACER,SWITCH:PLASTIC	71590	J-64281

Replaceable Mechanical Parts—413

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-35	136-0461-00		4	.	SKT, PL-IN ELEC:CKT CARD CONTACT	80009	136-0461-00
-36	136-0514-00		7	.	SOCKET, PLUG IN:MICROCIRCUIT, 8 CONTACT	73803	CS9002-8
-37	136-0269-02		4	.	SOCKET, PLUG-IN:14 CONTACT, LOW CLEARANCE	01295	C95140
-38	136-0260-02		1	.	SOCKET, PLUG-IN:16 CONTACT, LOW CLEARANCE	82647	C9316-18
-39	131-0589-00		3	.	TERM, PIN:0.46 L X 0.025 SQ. PH BRZ GL	22526	47350
-40	214-0579-00		11	.	TERM, TEST POINT: BRS CD PL	80009	214-0579-00
-41	136-0252-04		42	.	SOCKET, PIN TERM:0.188 INCH LONG	22526	75060-007
-42	214-2440-00		2	.	RECEPTACLE, PIN: CIRCUIT CARD	80009	214-2440-00
-43	-----		1	.	CKT BOARD ASSY: ECG(SEE A1 EPL) (ATTACHING PARTS)		
-44	211-0101-00		1	.	SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-45	348-0003-00		1	.	GROMMET, RUBBER: 0.312 INCH DIAMETER	70485	1411B6040
-46	337-1816-02		1	.	SHIELD, ELEC: ECG, FRONT (ATTACHING PARTS)	80009	337-1816-02
-47	211-0008-00		1	.	SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
-48	337-1817-00		1	.	CKT BOARD ASSY INCLUDES: SHIELD, ELEC: ECG REAR (ATTACHING PARTS)	80009	337-1817-00
-49	129-0338-00		1	.	POST, ELEC-MECH: HEX., 0.188 X 0.64 INCH LONG	80009	129-0338-00
-50	214-2440-00		2	.	RECEPTACLE, PIN: CIRCUIT CARD	80009	214-2440-00
-51	136-0461-00		4	.	SKT, PL-IN ELEC:CKT CARD CONTACT	80009	136-0461-00
-52	366-1559-00		4	.	PUSH BUTTON: GRAY	80009	366-1559-00
-53	384-1099-00		4	.	EXTENSION SHAFT: PUSH BUTTON, 1.54 INCH LONG	80009	384-1099-00
-54	-----		1	.	SWITCH, PUSH: (SEE S101 EPL)		
-55	361-0542-00		4	.	SPACER, SWITCH: PLASTIC	71590	J-64281
-56	131-0589-00		12	.	TERM, PIN: 0.46 L X 0.025 SQ. PH BRZ GL	22526	47350
-57	131-0608-00		3	.	TERMINAL, PIN: 0.365 L X 0.25 PH, BRZ, GOLD PL	22526	47357
-58	220-0449-00		1	.	NUT, SLEEVE: 4-40 X 0.188 X 0.50" LONG (ATTACHING PARTS)	80009	220-0449-00
-59	129-0613-00		1	.	SPACER, POST: 0.8 L, W/4-40 THD ONE END AL	80009	129-0613-00
-60	136-0269-02		2	.	SOCKET, PLUG-IN: 14 CONTACT, LOW CLEARANCE	01295	C95140
-61	136-0514-00		6	.	SOCKET, PLUG IN: MICROCIRCUIT, 8 CONTACT	73803	CS9002-8
-62	214-0579-00		9	.	TERM, TEST POINT: BRS CD PL	80009	214-0579-00
-63	136-0252-04		66	.	SOCKET, PIN TERM: 0.188 INCH LONG	22526	75060-007
-64	131-0993-00		2	.	BUS, CONDUCTOR: 2 WIRE BLACK	00779	530153-2
-65	-----		-	.	CKT BOARD ASSY: CONDITIONER(SEE A5 EPL) (ATTACHING PARTS)		
-66	211-0116-00	B010100 B020799	3	.	SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
	211-0116-00	B020800 B030599	2	.	SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH BRS	83385	OBD
	211-0207-00	B030600 B031299	2	.	SCR, ASSEM WSHR: 4-40 X 0.312 DOUBLE SEMS	83385	OBD
	211-0244-00	B031300	2	.	SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH STL	78189	OBD
	129-0725-00	B030800	1	.	SPACER, POST: 0.565 L, W/4-40 THD	80009	129-0725-00
	210-0004-00	B020800 B030699	1	.	WASHER, LOCK: #4 INTL, 0.015THK, STL CD PL	78189	1204-00-00-0541C
	210-0054-00	B030700	1	.	WASHER, LOCK: SPLIT, 0.118 ID X 0.212" OD STL	83385	OBD
-67	342-0400-00		1	.	INSUL, CKT CARD: CONDITIONER	80009	342-0400-00
-68	131-0993-00		2	.	CKT BOARD ASSY INCLUDES: BUS, CONDUCTOR: 2 WIRE BLACK (STANDARD AND OPTION 22 ONLY)	00779	530153-2
	131-0993-00		1	.	BUS, CONDUCTOR: 2 WIRE BLACK (OPTION 20 ONLY)	00779	530153-2
-69	136-0514-00		1	.	SOCKET, PLUG IN: MICROCIRCUIT, 8 CONTACT	73803	CS9002-8
-70	136-0269-02		26	.	SOCKET, PLUG-IN: 14 CONTACT, LOW CLEARANCE (STANDARD AND OPTION 22 ONLY)	01295	C95140
	136-0269-02		20	.	SOCKET, PLUG-IN: 14 CONTACT, LOW CLEARANCE (OPTION 20 ONLY)	01295	C95140
-71	136-0260-02		7	.	SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE	82647	C9316-18
-72	131-0589-00		72	.	TERM, PIN: 0.46 L X 0.025 SQ. PH BRZ GL	22526	47350
-73	214-0579-00		6	.	TERM, TEST POINT: BRS CD PL	80009	214-0579-00
-74	136-0252-04		18	.	SOCKET, PIN TERM: 0.188 INCH LONG	22526	75060-007

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-75	131-0608-00		20		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-76	131-2072-00		1		. TERM. SET,PIN:17 MALE CONT,RIGHT ANGLE	22526	65522-117
-77	131-2073-00		1		. TERM. SET,PIN:17 MALE CONT,RIGHT ANGLE	22526	65525-117
-78	-----		1		CKT BOARD ASSY:HIGH VOLTAGE(SEE A7 EPL) (ATTACHING PARTS)		
	211-0116-00		2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	210-1160-00		2		WASHER,NONMETAL:0.109 ID X 0.25 INCH OD - - - * - - -	86445	OBD
-79	342-0401-00		1		INSUL,CKT CARD:HIGH VOLTAGE	80009	342-0401-00
	-----		-		. CKT BOARD INCLUDES:		
-80	129-0576-00		2		. SPACER,POST:0.393 L,W/4-40 THD,BRS,0.21	80009	129-0576-00
-81	195-0125-00		1		. LEAD,ELECTRICAL:ANODE	80009	195-0125-00
-82	131-0589-00		3		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-83	136-0263-04		17		. SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	48059
-84	-----		2		TRANSISTOR:(SEE Q1972 Q1973 EPL) (ATTACHING PARTS FOR EACH)		
-85	211-0097-00		1		SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
-86	210-0586-00		1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL - - - * - - -	78189	211-041800-00
-87	-----		1		TRANSISTOR:(SEE Q1945 EPL) (ATTACHING PARTS)		
-88	211-0198-00		1		SCREW,MACHINE:4-40 X 0.438 PNH,STL,POZ	77250	OBD
-89	210-0586-00		1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
-90	210-0071-00		1		WASHER,SPR TNSN:0.146 ID X 0.323" OD,STL - - - * - - -	78189	4706-05-01-0531
-91	342-0163-00		1		INSULATOR,PLATE:XSTR,0.675 X 0.625 X 0.001"	80009	342-0163-00
	255-0319-00	XB020000	FT		PLASTIC SHEET:3X9 INCH,W/ADH ONE SIDE	80009	255-0319-00
-92	214-2539-00		1		HEAT SINK,XSTR:(2) TO-3 & (1) TO-27 (ATTACHING PARTS)	80009	214-2539-00
-93	211-0101-00		2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-94	-----		1		CKT BOARD ASSY:MAIN(SEE A6 EPL) (ATTACHING PARTS)		
-95	211-0101-00		8		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
-96	211-0014-00		1		SCREW,MACHINE:4-40 X 0.50 INCH,PNH STL	83385	OBD
-97	210-0586-00		1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL - - - * - - -	78189	211-041800-00
-98	220-0503-00	B010100 B019999	-		. CKT BOARD ASSY INCLUDES:		
	220-0824-00	B020000	4		. NUT BLOCK:0.5 X 0.188 X 0.75,TWO 4-40 THRU	80009	220-0503-00
			4		. NUT BLOCK:0.43 X 0.75 X 0.09,(2)4-40 THD (ATTACHING PARTS FOR EACH)	80009	220-0824-00
-99	211-0116-00		2		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS - - - * - - -	83385	OBD
-100	131-0993-00		1		. BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-101	366-1559-00		1		. PUSH BUTTON:GRAY	80009	366-1559-00
-102	384-1136-00		1		. EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-103	-----		1		. SWITCH,PUSH:(SEE S1532 EPL)		
-104	361-0542-00		2		. SPACER,SWITCH:PLASTIC	71590	J-64281
-105	131-2083-00		1		. BUS,CONDUCTOR:2,26 AWG,1.5 L	80009	131-2083-00
-106	131-0608-00		110		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-107	129-0561-00		3		. SPACER,POST:0.535 L,W-4-40 INTL ONE END	80009	129-0561-00
-108	131-2125-00		3		. CONN,RCPT,ELEC:CKT BD,2 X 10 FEMALE		
-109	136-0514-00		5		. SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	CS9002-8
-110	136-0269-02		8		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-111	136-0260-02		6		. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C9316-18
-112	214-0579-00		8		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-113	136-0252-04		117		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060-007
-114	131-0589-00		130		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-115	214-2441-00	B010100 B030859	8		. PIN,SHLDR,HDLS:CIRCUIT CARD	80009	214-2441-00
	214-2441-00	B030860	5		. PIN,SHLDR,HDLS:CIRCUIT CARD	80009	214-2441-00
	214-2895-00	B030860	3		. PIN,SHLDR,HDLS:CIRCUIT CARD	80009	214-2895-00
-116	131-0591-00		9		. CONTACT,ELEC:0.835 INCH LONG	22526	47352

Replaceable Mechanical Parts—413

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-117	-----	-----	1		. RES., THERMAL: (SEE RT1922 EPL)		
-118	386-3781-00		1		SUPPORT, CKT CD: MAIN (ATTACHING PARTS)	80009	386-3781-00
-119	211-0025-00		2		SCREW, MACHINE: 4-40 X 0.375 100 DEG, FLH STL - - - * - - -	83385	OBD
-120	337-1865-00		1		SHLD, ELEC CONN: ECG, TOP (ATTACHING PARTS)	80009	337-1865-00
-121	211-0007-00		2		SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL - - - * - - -	83385	OBD
-122	-----	-----	1		CONNECTOR, RCPT, : (SEE J130 EPL) (ATTACHING PARTS)		
-123	211-0233-00		2		SCREW, TPG, TC: 4-24 X 0.438, PNH, STL	83385	OBD
-124	210-0201-00		1		TERMINAL, LUG: SE #4 - - - * - - -	86928	A373-157-2
-125	348-0055-00		1		GROMMET, PLASTIC: 0.25 INCH DIA	80009	348-0055-00
-126	337-1866-00		1		SHIELD, ELEC CONN: ECG	80009	337-1866-00
-127	342-0189-00		1		INSULATOR, CONN: (ATTACHING PARTS)	80009	342-0189-00
-128	213-0267-00		2		SCREW, MACHINE: 4-24 X 0.375 INCH, PNH STL - - - * - - -	83385	OBD
-129	348-0530-00		2		FOOT, CORD WRAP: (ATTACHING PARTS FOR EACH)	80009	348-0530-00
-130	211-0571-00		2		SCREW, MACHINE: 6-32 X 2.50 INCHES, PNH, STL - - - * - - -	83385	OBD
-131	131-1703-00		1		CONN, PLUG, ELEC:	74545	8215-C
-132	343-0439-00		1		RTNR, CA TO CA: 0.269 OD, POLYETH BLACK	80009	343-0439-00
-133	175-1415-01		1		CABLE, PWR, ELEC: (ATTACHING PARTS)	80009	175-1415-01
-134	343-0440-00		1		RTNR, CABLE NIP.:	80009	343-0440-00
-135	211-0018-00		2		SCREW, MACHINE: 4-40 X 0.875 PNH, STL - - - * - - -	83385	OBD
-136	200-1561-00		1		CABLE NIP, ELEC:	80009	200-1561-00
-137	-----	-----	1		XFM, PWR STPDN: (SEE T1910 EPL)		
-138	348-0003-00		2		GROMMET, RUBBER: 0.312 INCH DIAMETER	70485	1411B6040
-139	200-0105-02		1		. COVER, ELEC XFMR:	80009	200-0105-02
-140	200-0105-01		1		. COVER, ELEC XFMR:	80009	200-0105-01
-141	211-0552-00		4		. SCREW, MACHINE: 6-32 X 2 INCH, PNH STL	83385	OBD
-142	210-0006-00		4		. WASHER, LOCK: #6 INTL, 0.018THK, STL CD PL	78189	1206-00-00-0541C
-143	210-0407-00		4		. NUT, PLAIN, HEX.: 6-32 X 0.25 INCH, BRS	73743	3038-0228-402
-144	210-0006-00		3		. WASHER, LOCK: #6 INTL, 0.018THK, STL CD PL	78189	1206-00-00-0541C
-145	210-0202-00		1		. TERMINAL, LUG: 0.146 ID, LOCKING, BRZ TINNED	78189	2104-06-00-2520N
	351-0543-00		1		GUIDE, CKT BD: SHIELD	80009	351-0543-00
	211-0030-00		2		SCREW, MACHINE: 2-56 X 0.25" 82 DEG, FLH STL	83385	OBD
	407-2066-00		1		BRACKET, GUIDE: ALUMINUM	80009	407-2066-00
-146	252-0571-00		FT		NEOPRENE EXTR: CHAN, 0.234 X 0.156	77969	1353
-147	334-3152-00		1		MARKER, IDENT: MARKED DANGERAC LINE	22670	OBD
-148	358-0281-00		1		GROMMET, PLASTIC: BLACK, U-SHAPED, 0.375ID	80009	358-0281-00
-149	337-2449-00		1		SHIELD, ELEC: VOLTAGE SELECTOR	80009	337-2449-00
-150	-----	-----	1		SWITCH, SLIDE: (SEE S1910 EPL) (ATTACHING PARTS)		
-151	211-0007-00		2		SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL - - - * - - -	83385	OBD
-152	-----	-----	2		SWITCH, BREAKER: (SEE CB1906 & CB1907 EPL)		
-153	131-0775-00	B010100 B031029	2		CONTACT, ELEC: HEX, 0.25 INCH W/6-32 1 END	88245	1601-A
	131-2368-00	B031030	2		TERMINAL STUD: 0.601 L, INSULATED	71279	5702432-020100
	334-3379-01	XB030850	1		MARKER, IDENT: MARKED GROUND SYMBOL	80009	334-3379-01
-154	210-0201-00		2		TERMINAL, LUG: SE #4 (ATTACHING PARTS)	86928	A373-157-2
-155	210-0551-00		2		NUT, PLAIN, HEX.: 4-40 X 0.25 INCH, STL	83385	OBD
	210-0457-00	XB030850	1		NUT, PLAIN, EXT W: 6-32 X 0.312 INCH, STL - - - * - - -	83385	OBD
-156	-----	-----	2		SEMICONV DEVICE: (SEE CR1910 CR1911 EPL) (ATTACHING PARTS FOR EACH)		
-157	210-0457-00		1		NUT, PLAIN, EXT W: 6-32 X 0.312 INCH, STL - - - * - - -	83385	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-158	-----		3		JACK, TELEPHONE: (SEE J1596, J1597 & J1592 EPL)		
-159	386-3514-01		1		PLATE, CONN MTG: REAR PANEL	80009	386-3514-01
	386-3813-00		1		PLATE CONN MTG:	80009	386-3813-00
	-----		-		(OPTION 20 ONLY)		
					(ATTACHING PARTS)		
-160	211-0097-00		4		SCREW, MACHINE: 4-40 X 0.312 INCH, PNH STL	83385	OBD
-161	210-0004-00		4		WASHER, LOCK: #4 INTL, 0.015THK, STL CD PL	78189	1204-00-00-0541C
	210-0012-00		3		WASHER, LOCK: INTL, 0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		
-162	366-1125-00		1		KNOB: GY, 0.127 ID X 0.531 H	80009	366-1125-00
	213-0153-00		1		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-163	-----		1		RES., NONWIR: (SEE R1731 EPL)		
					(ATTACHING PARTS)		
-164	210-0583-00		1		NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20224-402
-165	210-0940-00		1		WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL	79807	OBD
					- - - * - - -		
-166	366-0491-01		1		KNOB:	80009	366-0491-01
	213-0153-00		1		. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-167	-----		1		SWITCH, ROTARY: (SEE S1426 EPL)		
-168	343-0144-00		2		CLAMP, LOOP: 0.125 INCH ID, BLK NYLON	95987	1-8-2
	343-0144-00		2		CLAMP, LOOP: 0.125 INCH ID, BLK NYLON	95987	1-8-2
	-----		-		(OPTION 20 ONLY)		
					(ATTACHING PARTS FOR EACH)		
-169	210-0406-00		1		NUT, PLAIN, HEX.: 4-40 X 0.188 INCH, BRS	73743	2X12161-402
-170	210-0994-00		1		WASHER, FLAT: 0.125 ID X 0.25" OD, STL	86928	5714-147-20N
					- - - * - - -		
-171	-----		1		CONN, RCPT, ELEC: (SEE J816 EPL)		
					(ATTACHING PARTS)		
-172	211-0016-00		2		SCREW, MACHINE: 4-40 X 0.625 INCH, PNH STL	83385	OBD
-173	210-0586-00		2		NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL	78189	211-041800-00
					- - - * - - -		
-174	210-0201-00		1		TERMINAL, LUG: SE #4	86928	A373-157-2
-175	200-2118-00		1		COVER, HOLE:	80009	200-2118-00
	-----		-		(OPTION 20 ONLY)		
					(ATTACHING PARTS)		
-176	211-0016-00		2		SCREW, MACHINE: 4-40 X 0.625 INCH, PNH STL	83385	OBD
	-----		-		(OPTION 20 ONLY)		
-177	210-0586-00		2		NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL	78189	211-041800-00
	-----		-		(OPTION 20 ONLY)		
-178	210-0201-00		1		TERMINAL, LUG: SE #4	86928	A373-157-2
	-----		-		(OPTION 20 ONLY)		
					- - - * - - -		
-179	200-0072-00		1		NUT, PLAIN, KNURL:	80009	200-0072-00
-180	355-0503-00		1		STUD, SHOULDERED:	80009	355-0503-00
					(ATTACHING PARTS)		
-181	210-0410-00		1		NUT, PLAIN, HEX.: 10-32 X 0.312 INCH, BRS	73743	2X20003-402
-182	210-0010-00		1		WASHER, LOCK: INT, 0.20 ID X 0.376" OD, STL	78189	1210-00-00-0541C
					- - - * - - -		
-183	-----		1		CONNECTOR, RCPT: (SEE J626 EPL)		
					(ATTACHING PARTS)		
-184	343-0617-00		1		RETAINER, CONN: PLUG GUIDE	80009	343-0617-00
-185	211-0097-00		2		SCREW, MACHINE: 4-40 X 0.312 INCH, PNH STL	83385	OBD
					- - - * - - -		
-186	-----		2		JACK, TELEPHONE: (SEE J1401 & J1461 EPL)		
					(ATTACHING PARTS FOR EACH)		
	210-0012-00		1		WASHER, LOCK: INTL, 0.375 ID X 0.50" OD STL	78189	1220-02-00-0541C
					- - - * - - -		
-187	366-0261-01		1		KNOB:	80009	366-0261-01
	-----		-		(OPTION 20 ONLY)		
-188	-----		1		RES., VAR NONWIR: (SEE R866 EPL)		
					(ATTACHING PARTS)		
-189	220-0808-00		1		NUT, SLEEVE: 0.25-32 X 0.438 HEX X 0.75, BRS	80009	220-0808-00
-190	210-0046-00		1		WASHER, LOCK: INTL, 0.26 ID X 0.40" OD, STL	78189	1214-05-00-0541C
					- - - * - - -		

Replaceable Mechanical Parts—413

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-	175-2101-00		1		CA ASSY, SP, ELEC: 3, 26 AWG, 3.5 L	80009	175-2101-00
	134-0151-00	B010100 B031229	1		BUTTON, PLUG: 0.25 MTG HOLEDIA, NYLON	28520	P250
	134-0161-00	B031230	1		BUTTON, PLUG: 0.25 DIA, STEEL CD PL	57771	D4647
-191	333-2333-00		1		PANEL, REAR: 413	80009	333-2333-00
					(ATTACHING PARTS)		
-192	210-0586-00		4		NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL	78189	211-041800-00
	198-3584-00		1		WIRE SET, ELEC:	80009	198-3584-00
-193	175-0825-00		FT		. WIRE, ELECTRICAL: 2 WIRE RIBBON	80009	175-0825-00
-194	175-0826-00		FT		. WIRE, ELECTRICAL: 3 WIRE RIBBON	80009	175-0826-00
-195	175-0827-00		FT		. WIRE, ELECTRICAL: 4 WIRE RIBBON	08261	SS-0426-710610C
-196	175-0828-00		FT		. WIRE, ELECTRICAL: 5 WIRE RIBBON	08261	OBD
-197	175-0829-00		FT		. WIRE, ELECTRICAL: 6 WIRE RIBBON	08261	SS-0626-710610C
-198	175-0830-00		FT		. WIRE, ELECTRICAL: 7 WIRE RIBBON	08261	SS-0726-710610C
-199	175-0832-00		1		. WIRE, ELECTRICAL: 9 WIRE RIBBON	08261	SS-0926(1061)OC
-200	175-0833-00		1		. WIRE, ELECTRICAL: 10 WIRE RIBBON	08261	OBD
-201	352-0169-00		1		. HLDR, TERM CONN: 2 WIRE BLACK	80009	352-0169-00
	352-0169-04		1		. CONN BODY, PL, EL: 2 WIRE YELLOW	80009	352-0169-04
	352-0169-05		1		. CONN BODY, PL, EL: 2 WIRE GREEN	80009	352-0169-05
-202	352-0161-01		3		. CONN BODY, PL, EL: 3 WIRE BROWN	80009	352-0161-01
	352-0161-02		2		. CONN BODY, PL, EL: 3 WIRE RED	80009	352-0161-02
	352-0161-03		2		. CONN BODY, PL, EL: 3 WIRE ORANGE	80009	352-0161-03
	352-0161-04		1		. CONN BODY, PL, EL: 3 WIRE YELLOW	80009	352-0161-04
	352-0161-08		1		. CONN BODY, PL, EL: 3 WIRE GRAY	80009	352-0161-08
-203	352-0162-08		2		. CONN BODY, PL, EL: 4 WIRE GRAY	80009	352-0162-08
-204	352-0163-04		1		. CONN BODY, PL, EL: 5 WIRE YELLOW	80009	352-0163-04
	352-0163-05		1		. CONN BODY, PL, EL: 5 WIRE GREEN	80009	352-0163-05
-205	352-0164-01		2		. CONN BODY, PL, EL: 6 WIRE BROWN	80009	352-0164-01
	352-0164-02		1		. CONN BODY, PL, EL: 6 WIRE RED	80009	352-0164-02
	352-0164-04		1		. CONN BODY, PL, EL: 6 WIRE YELLOW	80009	352-0164-04
	352-0164-07		2		. HLDR, TERM CONN: 6 WIRE VIOLET	80009	352-0164-07
	352-0164-08		2		. CONN BODY, PL, EL: 6 WIRE GRAY	80009	352-0164-08
	352-0164-09		2		. CONN BODY, PL, EL: 6 WIRE WHITE	80009	352-0164-09
-206	352-0165-05		1		. CONN BODY, PL, EL: 7 WIRE GREEN	80009	352-0165-05
	352-0165-07		2		. CONN BODY, PL, EL: 7 WIRE VIOLET	80009	352-0165-07
	352-0167-02		2		. CONN BODY, PL, EL: 9 WIRE RED	80009	352-0167-02
-207	352-0168-03		2		. CONN BODY, PL, EL: 10 WIRE ORANGE	80009	352-0168-03
	352-0168-05		1		. CONN BODY, PL, EL: 10 WIRE GREEN	80009	352-0168-05
	352-0168-06		1		. CONN BODY, PL, EL: 10 WIRE BLUE	80009	352-0168-06
	352-0168-06		1		. CONN BODY, PL, EL: 10 WIRE BLUE	80009	352-0168-06
-208	352-0200-00		1		. HLDR, TERM CONN: 4 WIRE BLACK	80009	352-0200-00
	352-0200-01		1		. CONN BODY, PL, EL: 4 WIRE BROWN	80009	352-0200-01
-209	131-0621-00		3		. CONNECTOR, TERM: 22-26 AWG, BRS& CU BE GOLD	22526	46231
-210	131-0707-00		175		. CONNECTOR, TERM: 22-26 AWG, BRS& CU BE GOLD	22526	47439
-211	131-0792-00		2		. CONNECTOR, TERM: 18-20 AWG, CU BE GOLD PL	22526	46221
-212	-----		1		. LIGHT, IND: (SEE DS1585 EPL)		
-213	348-0003-00		1		. GROMMET, RUBBER: 0.312 INCH DIAMETER	70485	1411B6040
	334-3380-00 XB030739		2		MARKER, IDENT: MKD STATIC ELEC CAN DAMAGE	22670	OBD

STANDARD ACCESSORIES

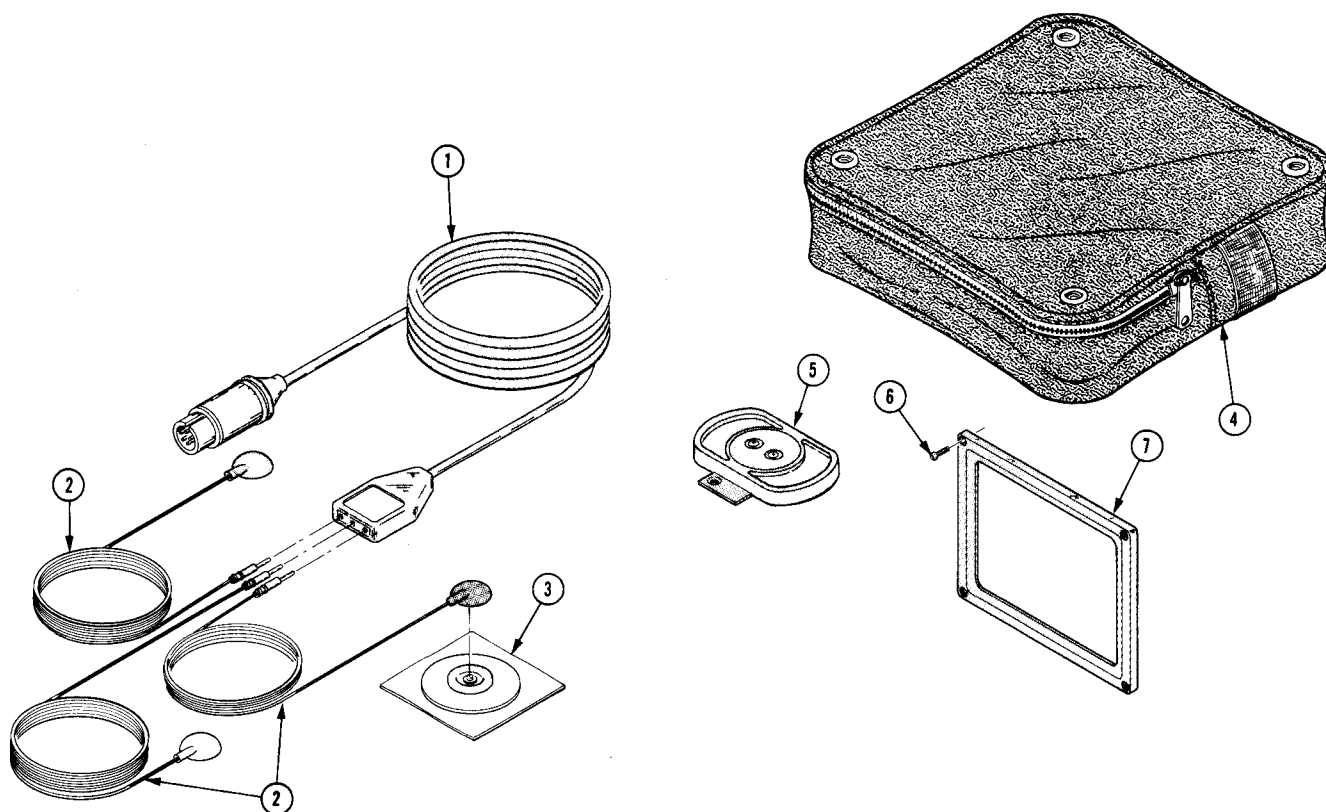


FIG. 3. ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
STANDARD ACCESSORIES											
-1	012-0739-00		1						PATIENT CABLE:TORSO,3 WIRE,5 PIN,132.0 L	54516	K-2365
-2	012-0502-00	B010100 B030629	2						WIRE,ELECTRODE:3,L/R ARM,L LEG,18 L,SNAPS	80009	012-0502-00
	012-0502-00	B030630	1						WIRE,ELECTRODE:3,L/R ARM,L LEG,18 L,SNAPS	80009	012-0502-00
-3	-----		9						ELECTRODE,ECG:INFANT,PREGELLED DISPOSABLE	50060	OBD
	-----		-						(AVAILABLE ONLY IN PACKS OF 30,		
	-----		-						PART NUMBER 119-0898-00)		
-4	016-0560-00		1						POUCH,ACCESSORY:MEDICAL MONITOR	80009	016-0560-00
-5	014-0054-00		1						ADAPTER,MTG:W/PLATE AND HDWR	80009	014-0054-00
-6	211-0646-00		4						SCREW MACHINE:2-56 X 0.375 INCH,PNH,STL	12360	OBD
-7	200-1547-01		1						BEZEL,CRT:	80009	200-1547-01
	070-2276-00		1						MANUAL,TECH:OPERATOR	80009	070-2276-00
	070-2277-00		1						MANUAL,TECH:INSTRUCTION	80009	070-2277-00
	-----		1						ELECTRODE ECG:ADULT,PREGELLED DISPOSABLE		
	-----		-						(OPTION 22 ONLY - AVAILABLE ONLY IN PACKS		
	-----		-						OF 30, PART NUMBER 119-0353-01)		



Tektronix, Inc.

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 (212) 895-9215

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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω .	107 - Risetime less than 3.0 ns into 50 Ω .
108	PG 501 - 5 V output pulse; 3.5 ns Risetime	108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0532-01		
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	181 - Multiple time-marks
184		184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μ s.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Separate trigger pulses, from 5 sec to 0.1 μ s. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in Instruments require TM 500-Series Power Module.

MANUAL CHANGE INFORMATION

PRODUCT 400, 401, 408, 412
413 & 414 SERVICE MANUALS

CHANGE REFERENCE C8/378
DATE 3-15-78

CHANGE:

DESCRIPTION

BATTERY USE AND CARE

THIS INFORMATION SUPERSEDES ALL SIMILAR INFORMATION
CONTAINED ELSEWHERE IN THIS MANUAL

CONTENTS OF THIS SECTION:

1. BATTERY CHARGING INSTRUCTIONS AND RELATED INFORMATION,
2. INSTRUCTIONS FOR A PERIODIC BATTERY-OPERATING-TIME TEST WHICH THE USER SHOULD PERFORM,
3. A CHART WHICH SHOWS THE BATTERY CHARGING AND OPERATING TIMES APPROPRIATE FOR VARIOUS MONITORS, AND
4. A MAINTENANCE PLAN FOR QUALIFIED SERVICE PERSONNEL.

1. BATTERY CHARGING INSTRUCTIONS

- A. 16 HOURS MINIMUM ARE REQUIRED TO RECHARGE A DEPLETED BATTERY. CONNECT THE LINE CORD PLUG TO A "HOSPITAL GRADE" AC OUTLET.

LONGER CHARGING TIME IS REQUIRED UNDER CERTAIN CIRCUMSTANCES. SEE THE TIME CHART ON A LATER PAGE OF THIS SECTION.

- B. CHARGE IN A COOL PLACE; PREFERABLY NO WARMER THAN $+22^{\circ}\text{C}$ ($\approx +72^{\circ}\text{F}$).

HIGHER TEMPERATURES PREVENT THE BATTERY FROM ACCEPTING MAXIMUM CHARGE. LONGER CHARGING TIME WILL ONLY PARTIALLY COMPENSATE FOR A HIGH TEMPERATURE. NO CHARGING WILL OCCUR WHEN THE TEMPERATURE EXCEEDS $+40^{\circ}\text{C}$ ($+104^{\circ}\text{F}$).

MAXIMUM BATTERY OPERATING TIME IS OBTAINED WHEN CHARGING IS DONE WITH THE MONITOR TURNED

CHANGE:	DESCRIPTION
	<p>OFF AND IN A COOL PLACE. WITH THE MONITOR OFF, THE INTERNAL TEMPERATURE WILL BE LOWER.</p> <p>C. AVOID EXCESSIVE CHARGING.</p> <p>IF THE MONITOR IS NOT BEING USED, TURN IT OFF. UNPLUG IT FROM THE AC OUTLET WHEN THE BATTERY IS FULLY CHARGED.</p> <p>THE BATTERY WILL GRADUALLY DISCHARGE ITSELF OVER A TWO TO SIX MONTH PERIOD AND WILL, THEREFORE, REQUIRE RECHARGING WHEN IT IS AGAIN PLACED INTO USE.</p> <p>APPLICATIONS, SUCH AS USE IN INTENSIVE CARE, MAY REQUIRE CONTINUOUS USE AND, THEREFORE, WILL REQUIRE THE MONITOR TO BE CONTINUOUSLY CONNECTED TO AN AC OUTLET. WEEKS OR MONTHS OF EXCESSIVE CHARGING RESULT. WHEN NEXT USED ON BATTERY, THE OPERATING TIME MAY BE SIGNIFICANTLY LESS THAN THE LISTED, TYPICAL AMOUNT.</p> <p>2. BATTERY OPERATING TIME TEST</p> <p>OCCASIONALLY CHECK OPERATING TIME AS FOLLOWS:</p> <p>A. CHARGE FULLY. SEE THE TIME CHART ON A LATER PAGE OF THIS SECTION.</p> <p>B. OPERATE MONITOR ON BATTERY UNTIL AUTOMATIC SHUTDOWN OCCURS.</p> <p>C. NOTE THE OPERATING TIME.</p> <p>IF THE OPERATING TIME IS SIGNIFICANTLY LESS THAN LISTED ON THE CHART AND BECOMES, THEREFORE, UNSUITABLE FOR YOUR APPLICATION, REFER THE MONITOR FOR SERVICE.</p>

TEKTRONIX MEDICAL MONITORS BATTERY CHARGING AND OPERATING TIMES

MONITOR TYPE	CHARGING HOURS @ 20-25°C AMBIENT			OPERATING HOURS ^{①②}	
	D-CELL BATTERY	F-CELL BATTERY		D-CELL BATTERY	F-CELL BATTERY
	EITHER OPERATING OR NOT	NOT OPERATING	FULLY OPERATING	TYPICAL	TYPICAL
408 MONITOR	16	16	18	3.5	5.6
w/400 RECORDER	③	16	20④		5.3④
w/400 RECORDER	③	16	26⑤		4.6⑤
412 MONITOR	16	16	18	2.5	4.0
w/400 RECORDER	③	16	20④		3.8④
w/400 RECORDER	③	16	26⑤		3.3⑤
413 MONITOR	16	16	18	1.6	2.6
w/400 RECORDER	③	16	20④		2.5④
w/400 RECORDER	③	16	26⑤		2.3⑤
w/401 DRM	③	16	50		1.9
w/BOTH 400 & 401	③	16	⑦		1.8④
414 MONITOR	16	16	18	1.7	2.7
w/400 RECORDER	③	16	20④		2.6④
w/400 RECORDER	③	16	26⑤		2.4⑤
w/400 RECORDER	③	16	22⑥		2.5⑥
w/401 DRM	③	16	50		2.1
w/BOTH 400 & 401	③	16	⑦		2.0④

Footnotes:

- Operating times listed are for new battery packs which have been charged while the monitor is turned off. For battery packs charged while the monitor was operating, reduce the listed time by about one-third.
- Operating times listed assume that all monitor capabilities are being used and with typical trace positions and sizes.
- Combination not recommended.
- With Recorder producing four 14-second strips per hour.
- With Recorder producing twenty 14-second strips per hour.
- With Option 3 Recorder producing four 28-second strips per hour.
- Monitor can be operating, but either or both the Recorder or DRM must be turned off for charging to take place.

CHANGE:	DESCRIPTION
<p>4. MAINTENANCE</p> <p>THE FOLLOWING PROCEDURES ARE TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.</p> <p>WHEN A BATTERY PROVIDES SIGNIFICANTLY LESS THAN THE RATED OPERATING TIME, THERE ARE THREE ALTERNATIVES:</p> <ul style="list-style-type: none">A. REPLACE IT WITH A NEW BATTERY, ORB. ATTEMPT TO REJUVENATE THE BATTERY, ORC. CONTINUE TO USE THE BATTERY, AS IS. <p>ATTEMPTED REJUVENATION CARRIES THE RISK THAT ONE OR MORE CELLS MAY BECOME SHORT CIRCUITED INTERNALLY AND MUST THEN BE REPLACED. THIS RISK IS OF LITTLE CONSEQUENCE IF IT HAS ALREADY BEEN DECIDED THAT THE BATTERY CAN NO LONGER BE USED.</p> <p>REJUVENATION CONSISTS OF:</p> <ul style="list-style-type: none">A. DEEP DISCHARGEB. RECHARGEC. DEEP DISCHARGED. RECHARGE <p>THIS PROCEDURE SHOULD CORRECT ANY ACCUMULATED CHARGE IMBALANCE AND REFORM THE CRYSTALLINE STRUCTURE OF THE CELL PLATES. IF ADEQUATE OPERATING TIME IS NOT RESTORED, THE BATTERY SHOULD BE REPLACED.</p> <p>DEEP DISCHARGE IS ACCOMPLISHED BY CONNECTING A RESISTOR ACROSS THE BATTERY. RESISTOR VALUE SHOULD BE ABOUT TEN OHMS AND THE POWER RATING SHOULD BE AT LEAST FIVE WATTS (TEK PART NO. 308-0399-00). THE RESISTOR WILL GET HOT, SO TAKE APPROPRIATE PRECAUTIONS. THE RESISTOR SHOULD REMAIN CONNECTED UNTIL THE BATTERY VOLTAGE DROPS BELOW ONE VOLT.</p>	
PAGE 4 OF 6	

CHANGE:	DESCRIPTION						
	<p>BATTERY RECHARGING CAN, OF COURSE, BE ACCOMPLISHED THROUGH IT'S MONITOR, BUT YOUR MONITORS NEED NOT BE KEPT IN THE MAINTENANCE AREA WHILE THIS REJUVENATION IS PERFORMED. THE MONITOR CAN BE USED ON AC LINE WITHOUT A BATTERY INSTALLED (UNLESS THE MONITOR IS EQUIPPED WITH A 400 RECORDER AND/OR A 401 DIGITAL READOUT MODULE). HOWEVER, THIS MAY BE INCOMPATIBLE WITH THE USER'S NEEDS.</p> <p>RECHARGING SHOULD BE DONE WITH A RELATIVELY CONSTANT CURRENT SOURCE, NOT A VOLTAGE SOURCE AS WITH LEAD-ACID BATTERIES. THIS CAN BE ACCOMPLISHED BY PUTTING A SUITABLE RESISTOR IN SERIES WITH A POWER SUPPLY. THE PACK VOLTAGE WILL RANGE FROM AS LOW AS 4.6 VOLTS DURING THE LATTER PHASE OF DISCHARGING TO AS HIGH AS 6 VOLTS DURING THE LATTER PHASE OF CHARGING.</p> <p>THE RECOMMENDED CHARGING CURRENTS FOR THIS PURPOSE ARE:</p> <table><tr><td>D - CELLS</td><td>250 TO 350 mA</td><td>(BATTERY PACK - TEK PART No.: 119-0441-01)</td></tr><tr><td>F - CELLS</td><td>400 TO 600 mA</td><td>(BATTERY PACK - TEK PART No.: 119-0443-01)</td></tr></table> <p>THE FOLLOWING IS RECOMMENDED. BUY EXTRA BATTERY PACKS, PERHAPS ONE EXTRA FOR EACH FIVE MONITORS IN USE. IF YOU USE BOTH "D" AND "F" CELL BATTERIES, THEY MUST BE CONSIDERED SEPARATELY. PUT A NEW BATTERY IN THE MONITOR AND RETURN IT FOR USE WHILE THE REJUVENATION PROCEDURE IS PERFORMED. (NOTE: MONITORS EQUIPPED WITH D-CELL PACKS CAN BE CONVERTED TO F-CELL PACKS BY INSTALLING AN F-CELL MOD KIT - TEK PART No.: 040-0710-00).</p> <p>IT IS SUGGESTED THAT EACH BATTERY PACK BE MARKED WITH AN IDENTIFYING NUMBER AND THAT BATTERY SERVICE RECORDS BE KEPT.</p>	D - CELLS	250 TO 350 mA	(BATTERY PACK - TEK PART No.: 119-0441-01)	F - CELLS	400 TO 600 mA	(BATTERY PACK - TEK PART No.: 119-0443-01)
D - CELLS	250 TO 350 mA	(BATTERY PACK - TEK PART No.: 119-0441-01)					
F - CELLS	400 TO 600 mA	(BATTERY PACK - TEK PART No.: 119-0443-01)					

PAGE 5 OF 6

CHANGE:	DESCRIPTION
	<p>BATTERY PACKS WHICH FAIL TO REJUVENATE MAY BE REPAIRABLE BY REPLACING THE DEFECTIVE CELL(S). THERE ARE SEVERAL THINGS TO KEEP IN MIND WHEN REPLACING CELLS:</p> <ol style="list-style-type: none">1. REPLACE CELLS WHICH FAIL TO DELIVER AT LEAST 75% OF THEIR LISTED, TYPICAL OPERATING TIME.2. WHEN A BATTERY PACK HAS BEEN IN SERVICE MORE THAN ONE YEAR, IT IS PROBABLY WISE TO REPLACE ALL OF THE CELLS WHEN THE FIRST BAD CELL IS DETECTED.3. REPLACEMENT CELLS SHOULD BE OBTAINED FROM TEKTRONIX BECAUSE THESE SPECIAL CELLS ARE DIFFICULT TO OBTAIN OTHERWISE. LOCALLY AVAILABLE CELLS TYPICALLY HAVE LOWER CAPACITY, NARROWER TEMPERATURE RANGE AND CANNOT TOLERATE THE MAGNITUDE OF CHARGING CURRENT PROVIDED BY THE MONITOR.4. MINIMIZE THE AMOUNT OF HEAT TRANSFERRED FROM SOLDERING IRON TO CELL BODY. BEND THE SOLDER TAB OUTWARD, AWAY FROM THE CELL BODY AND PLACE A HEAT-SINK CLIP BETWEEN THE CELL BODY AND THE SOLDER AREA. NEVER SOLDER DIRECTLY TO THE CELL BODY.

Date: 9-4-79

Change Reference: C9/979

Product: 413 Service

Manual Part No.: 070-2277-00

DESCRIPTION

TEXT CORRECTIONS

Page v, fourth line from the bottom

CHANGE TO READ:

Temperature Sensors: Dual-thermistor temperature probe Models 701
 and 702, available from Yellow Springs Instru-
 ment Co., Box 279, Yellow Springs, Ohio 45387

Page 1-8, left column, under TEMPERATURE heading

CHANGE TO READ: Accuracy (with Yellow Springs Instrument Co. probe Models
 701 or 702).

Date: 3-28-80

Change Reference: C14/380

Product: 413 SERVICE

Manual Part No.: 070-2277-00

DESCRIPTION

TEXT ADDITION

Page 2-1 left column, at the end of the first paragraph

ADD:

However, for proper functioning of the instrument during power mains transients, the battery pack must be installed and in good working order. Check that the battery status indicator on the monitor front panel is green (battery charged) even when the instrument is operating from mains power.

DESCRIPTION

408 (070-1525-00) Page 4-6 (Page 4-7)
412 (070-1523-00) Page 4-7
413 (070-2277-00) Page 4-9 (Remove existing instructions)
414 (070-2042-00) Page 4-8 (Page 4-10)

TEXT ADDITION**ADD:****Replacing Battery Fuses**

1. Remove the top and bottom covers from the instrument.
2. Turn the instrument upside down and unplug the ribbon cable that connects the battery pack to the main circuit board.
3. Turn the instrument over and remove the two flat-head screws that hold the battery pack in the instrument.
4. Remove the four nuts that hold the cover on the battery pack. Do not loosen or remove the nut that holds the ground lead to the battery pack cover.
5. Fold back the fishpaper that covers the cells to expose the circuit board that mounts the fuses between the ends of the two center cells.
6. Using a low-wattage soldering iron, unsolder and remove the defective fuses.
7. Remove the solder from the holes in the circuit board using a desoldering tool, a solder wick, or a sharp toothpick.

CAUTION

Excess heat can damage fuses. Use low-wattage soldering iron and apply only enough heat to make the solder flow properly.

8. Bend the leads on the new fuses to the proper shape, insert the leads into the holes in the circuit board, and solder. Trim the excess length from the fuse leads.
9. Carefully fold the fishpaper back to its original shape and position over the cells, replace the cover on the battery pack, replace the nuts on the studs, and reinstall the battery pack in the instrument.
10. Reconnect the ribbon cable onto the main board. Plug orientation is not important.

MANUAL CHANGE INFORMATION

COMMITTED TO EXCELLENCE

Date: 6-17-80

Change Reference: M39946 REV.

Product: 413

EFF SN B050000

Manual Part No.: 070-2277-00

DESCRIPTION

REPLACEABLE ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

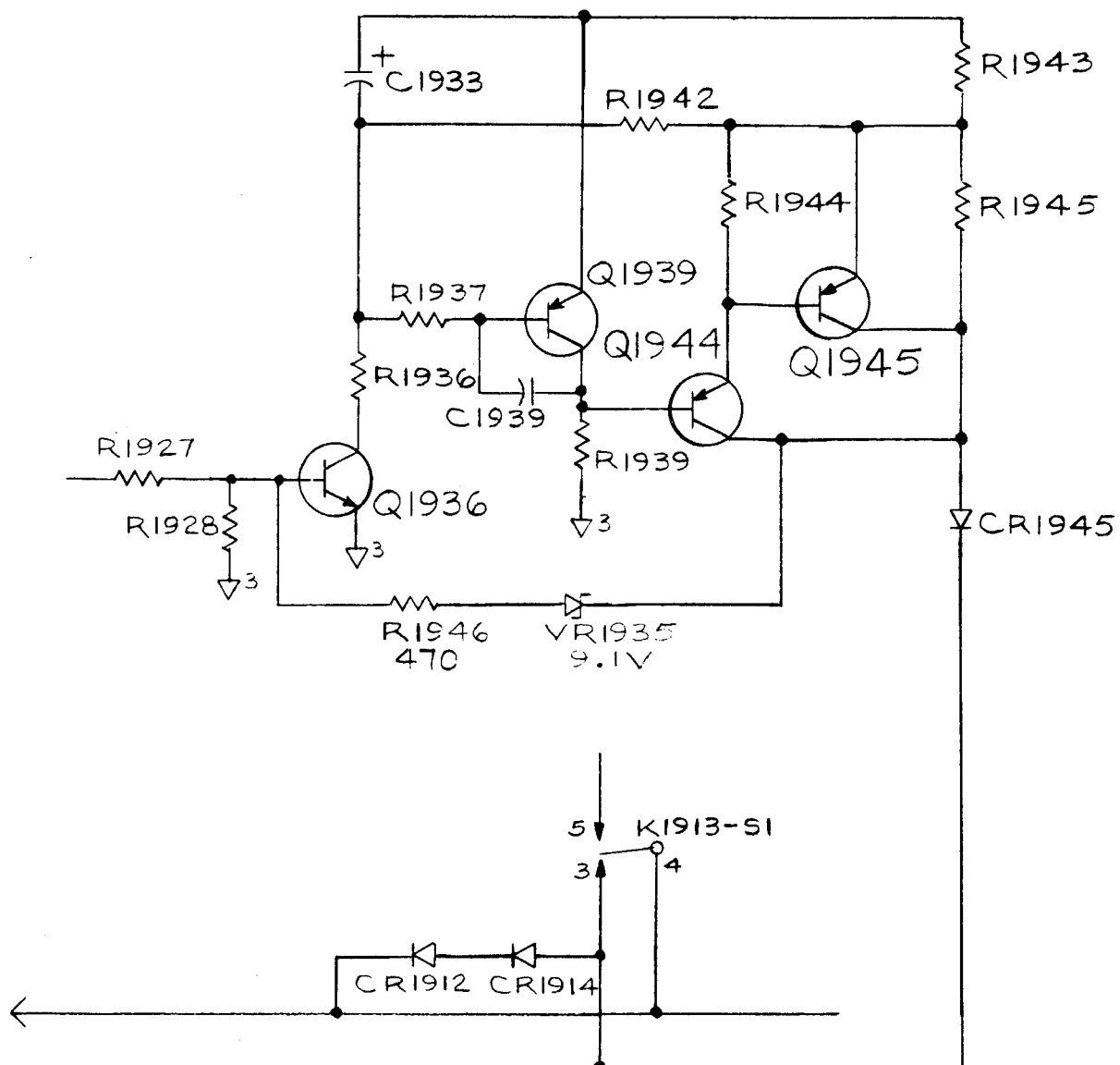
CHANGE TO:

A6 670-5068-03 CKT BOARD ASSY:MOTHER

ADD:

CR1912	152-0198-00	SEMICONDUCTOR DEVICE: SILICON, 200V, 3A, 1N4721
CR1914	152-0198-00	SEMICONDUCTOR DEVICE: SILICON, 200V, 3A, 1N4721
R1946	315-0471-00	RES., FXD, CMPSN: 470 OHM, 5%, 0.25W
VR1935	152-0306-00	SEMICONDUCTOR DEVICE: ZENER, 0.4W, 9.1V, 5%, 1N960B

DIAGRAM 9 POWER SUPPLY AND CRT - Partial



Date: 1-29-81 Change Reference: C20/181Product: 400,401,408,412,413,413A & 414 SERVICE Manual Part No.: see below**DESCRIPTION**

400 (070-2429-00)

401 (070-2497-00)

408 (070-1525-00)

412 (070-1523-00)

413 (070-2277-00)

413A (070-2894-00)

414 (070-2042-01)

PORTABLE PATIENT MONITORS

After 12 January 1981, serial numbers of the above named instruments start with "C" instead of the beginning "B" previously used.

A number of instruments were already assembled and awaiting shipment when the change in serial numbers occurred. On these instruments the serial number tag on the rear of the instrument will commence with "C"; the serial number on the frame or chassis will be the same except that it will begin with a "B".

Date: 2-13-81 Change Reference: M40832

Product: 413 PORTABLE NEONATAL MONITOR Manual Part No.: 070-2277-00

DESCRIPTION

FIG. 3. ACCESSORIES

DELETE:

Fig. -3	- - - - -	9 ELECTRODE, ECG: INFANT, PREGELLED DISPOSABLE
	- - - - -	(AVAILABLE ONLY IN PACKS OF 30,
	- - - - -	PART NUMBER 119-0898-00)